International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho$_2$: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

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The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

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5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
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International Journal of Research

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Gender	28.612	1	28.612	.198	.657	NS
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Total	361817.000	168				
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The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

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e-ISSN: 2348-795X

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736^{a}	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho$_2$: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736^a	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Introduction

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

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The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

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The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

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Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

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International Journal of Research
p-ISSN: 2348-6848
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Volume 08 Issue 02
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		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

Instructional Approach	Gender	N	Pretest $\bar{x}$	Pretest SD	Posttest $\bar{x}$	Posttest SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

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Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

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Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

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Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAI) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

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e-ISSN: 2348-795X

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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho$_2$: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

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Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

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International Journal of Research

p-ISSN: 2348-6848
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5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

Instructional Approach	Gender	N	Pretest $\bar{x}$	Pretest SD	Posttest $\bar{x}$	Posttest SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

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e-ISSN: 2348-795X

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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

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The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research
International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736^a	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
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Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

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Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho₁: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

Instructional Approach	Gender	N	Pretest $\bar{x}$	Pretest SD	Posttest $\bar{x}$	Posttest SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAI) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAI) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736^a	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

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p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

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The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAI) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho$_2$: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

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5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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p-ISSN: 2348-6848
e-ISSN: 2348-795X
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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
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Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
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Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

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e-ISSN: 2348-795X
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

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e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research
International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research
International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho$_2$: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research
International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
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The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability $r = 0.87$ which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3
$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings
Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

BY

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		Posttest		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

IJR

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

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Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: **Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups**

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

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Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

$H0_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
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5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7573.777[a]	2	.889	26.273	.000	
Intercept	32009.008	1	32009.008	222.074	.000	
Pretest	5064.255	1	5064.255	35.135	.000	
Strategies	632.152	1	632.152	4.386	.038	S
Error	23782.503	165	144.136			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 2 shows that with respect to mean conceptual change scores of students taught electrochemistry with 5E's learning cycle andcomputer assisted instruction, an F-ratio of 4.386was obtained with associated probability value of 0.03. Since the associated

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

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February 2021

probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research

p-ISSN: 2348-6848

e-ISSN: 2348-795X

Volume 08 Issue 02

February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Relative Effectiveness Of 5e's Learning Cycle And Computer Assisted Instruction On Students' Conceptual Change in Electrochemistry

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Abstract

This study sought to determine the relative effectiveness of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry. The study was carried out in two co-educational schools in Asaba Educational Zone of Delta State. The sample size was 168Senior Secondary School two (SS2) students because the concept under study is taught in this class.The study was necessitated due to conceptual difficulties students have about the concept 'electrochemistry' because of some held misconceptions. Quasi- experimental design was used for the study with three research questions and three hypotheses. The Electrochemistry Conceptual change Test (ECT) developed by the researchers was used to collect data for analysis. There were two treatment groups. The groups received pre-test and post-test

independently. The research questions were answered using mean and standard deviations while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.The result revealed that the computer assisted instruction was more efficacious than the 5E's learning cycle in bringing about conceptual change. Based on the result, appropriate recommendations were made which include the training of teachers for effective use of computer animated assisted instructional strategy in teaching.

Keywords: Conceptual change, misconception, chemistryand electrochemistry.

Introduction

Chemistry is a branch of science that deals with the study of the composition, structure, properties and change of matter (Mordi, 2014). Chemistry plays fundamental roles in the economic, scientific and technological development of nations. This is because it is required in the training of chemists, physicists, engineers, pharmacists, doctors, agriculturists and science educators that nations depend on for economic development and progress. This implies that there is need to ensure that a solid foundation is laid for effective and efficient chemistry education. In fact, the basic knowledge got from chemistry concepts at the secondary school level are needed for sustainable development. Such concepts in chemistry is electrochemistry.

Electrochemistry is a branch of chemistry that deals with the chemical action of electricity and the production of electricity by chemical reactions (Atkins, 2006). This concept if well understood can be applied in tackling societal problem of rusting, purification of metals and extraction among others. Obomanor and Onuoha (2012)among others however noted that students enter the chemistry class with some non-scientific ideas that affect their understanding of electrochemistry.These non-scientific ideas are called misconception. The misconceptions in electrochemistry that have been noted include; electrons flow in an electrolyte¸ batteries are recharged by sunning, all substances in the liquid state can allow current to pass through them, thus electrocution can occur among others.These are wrong non-scientific ideas of electrochemical cells which must be erased from the students' minds. Iwuozor (2013) from the zone under study opined that students have difficulties in understanding the concept of electrochemistry. Could this difficulties be as a result of held misconceptions about electrochemistry? The quest to answer this question necessitated this study.Students' prior knowledge is often faulty or incomplete and results in misconceptions about concepts and this affects their understanding. This suggests that before receiving any form of formal teaching on a concept, for example electrochemistry, students already have some misconceptions about the concept. Considering the importance of electrochemistry to man, there is need to explore ways of removing students misconceptions and hence attain meaningful understanding and better performance in the subject.The process of removing students' misconceptions and replacing them with scientifically accepted idea is called conceptual change.

Conceptual change is a learning process in which an existing conception (idea or belief) held by a student is restructured. It is a process that changes or replaces an existing conception with a new conception (Madu, 2004). Hence conceptual change occurs during instruction where the learner is actively involved.Several research reports (Olodu 2013; Obiekwe, 2008 & Ogbonna, 2003) indicate that many science teachers prefer the traditional methods of teaching and shy away from innovative activity-oriented teaching methods. Such teaching involve the use of conventional teaching methods such as lecture method that is not learner-centered. Some of the activity-based teaching methods/strategies advocated by constructivists include: the concept mapping, co-operative learning, computer animation, 5E's learning cycle, experimentation among others. Researchers (Uzoka, Okotcha & Oghenejode, 2015; Olodu, 2013; Nwosu, 2012; Obi, 2003; Abraham & Renner 1986) attested to the efficacy of the 5E's learning cycle and the computer assisted instruction on the achievement of science students. Would these strategies also bring about conceptual change of students in electrochemistry? The quest to answer this question underscores this research.The 5E's as a pedagogical approach involves five steps/stages. These are: engagement/problem identification, experimenting/problem solving, explanation/clarification, elaboration/generalization and evaluation/feedback.

Computer is one of the latest media which technology has brought for use by mankind and it has been widely used in this 21st century. In the field of education, computer has been used in a variety of ways namely, instructional process which consists of Computer Assisted Instruction (CAl) and Computer Management Instruction (CMI). In the instructional process, computer assisted instruction is used to instruct students in various subjects. Information is presented to the learner using the computer through interactive process involving drill and practice, tutorial and simulation (animation). Animation for the purpose of this study is defined as a process of moving and changing any object on the computer screen to replicate a simulation of a theoretical, dynamic, abstract and evolving process, event or phenomena.

The issue of parity and disparity in the way male and female students learn science have formed an important focus of research in recent years. This is in recognition of the influence of gender and the position of the learner in any learning process. Many reasons have been attributed to the gender gaps with a fundamental reason on the way science is taught in our schools (Madu, 2004). In view of the contradicting results, a new investigation seems inevitable in order to throw more light on the issue concerning the influence of gender on conceptual change in electrochemistry especially when two different constructivists' methods of equal weighting are employed.

Statement of Problem

Chemistry is one of the three basic sciences Nigeria needs for sustainable development.Research has shown that students have conceptual difficulties in understanding the concept of electrochemistry. This difficulty may be due to held misconceptions about the concept.Alternative conceptions play a larger role in learning chemistry as well as other sciences. This tends to affect the performance of chemistry students in internal and external examinations

and will hamper sustainable development. The traditional methods of instruction such as lecture method among others predominantly used in teaching chemistry do not encourage active participation of learners in the teaching-learning process and do not take into consideration students' prior conceptions, hence not suitable for conceptual change. The effectiveness of the 5E's learning cycle and Computer Assisted Instruction in bringing about conceptual change need to be ascertained. Hence the major issue of this study posed as a question is: What are students' conceptual change in electrochemistry using the 5E's learning cycle and Computer Assisted Instruction (CAI)?

Purpose of the Study

The purpose of this study was to empirically examine students' conceptual change in electrochemistry using two constructivist's methods of instruction. The study specifically sought to:

1. Determine the effect of 5E's learning cycle and computer assisted instruction on students' conceptual change in electrochemistry.
2. Find out the influence of gender on students' conceptual change in electrochemistry.
3. Find the extent to which the instructional strategies interact with gender to affect students' conceptual change in electrochemistry.

Scope of the Study

This study was carried out in Asaba Educational Zone of Delta State. The study was limited to Senior Secondary School two (SS2) students, because the concept, electrochemistry, is taught in this class. The choice of the topic was based on the fact that students have conceptual difficulties on the topic which could be because of held misconceptions.

Research Questions

The following research questions guided the study

1. What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?
2. What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Hypotheses

The following research hypotheses were formulated to guide the research and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Ho_3: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

Methodology

Design of the Study

The study adopted the quasi-experimental design. Specifically, it is non-equivalent control group design because it involves the use of intact classes that would ensure that regular class periods are not altered.

Area of the Study

The study was carried out in Asaba Educational Zone of Delta State. The choice of this zone was based on the observed conceptual difficulty students have towards electrochemistry. Also, the researchers reside in this zone hence had the opportunity of personally teaching the students.

Population of the Study

The population of this study consists of the entire Senior Secondary School two (SS2) chemistry students in the state-owned secondary schools located in Asaba Educational Zone of Delta State numbering 1,240. The choice of SS2 is based on the fact that the content for the study are taught in SS2. The subjects of the study were from the co-educational schools to ensure that the students (male and female) share a common learning environment.

Sample and Sampling Technique

The sample of the study consistedof about 168 students from two co-educational schools in Asaba educational zone in Delta State. Purposive sampling was used to select two schools that hadwell equipped laboratories and computer rooms.

Instrument for Data Collection

The instrument for this study was electrochemistry conceptual change Test (ECT). The instrument was used to gather data for the pretest and post-test. The pretest was administered a week before instructional procedures while the post-test was administered after instruction.

Construction, Validation and Reliability of Instrument

The electrochemistry conceptual change test (ECT) was constructed by the researchers and validated by experts in science education. The instrument consists of thirty (30) short essay items whose reliability was tested using Pearson coefficient of correlation. It was found to be highly reliable with coefficient of reliability r = 0.87 which proved to be highly reliable.

Method of Data Collection

Before the experiment, researchers with the help of the research assistants administered the p-test to the students in the two groups. After this, the experimental groups were exposed to the treatments. This was followed by thepost-test.

Method of Data Analysis

The research questionswere answered using mean and standard deviation while two way analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1:

What are the effects of using 5E's learning cycle and the computer assisted instruction on students' conceptual change in electrochemistry?

International Journal of Research

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
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Table 1: **Mean and Standard Deviation of pretest and posttest after exposure to 5E's learning cycle and the computer assisted instruction**

		Pretest		Posttest		
Instructional Approaches	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean Gain**
5E's L. C	81	18.01	9.50	40.35	13.99	22.34
C. A. I	87	24.66	10.56	48.08	12.37	23.42

Result on Table 1 shows that for each of the groups, the posttest conceptual change mean scores are greater than the pretest conceptual mean scores with the group taught electrochemistry using computer assisted instruction having a higher conceptual change mean gain (23.42>22.34). This is an indication that computer assisted instruction improved students' conceptual change in electrochemistry than 5E's learning cycle.

Hypothesis 1

Ho$_1$: There is no significant difference in the mean conceptual change scores of students taught electrochemistry with 5E's learning cycle and those taught with computer assisted instruction.

Table 2: Analysis of Covariance (ANCOVA) results showing effects of strategies on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
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International Journal of Research
p-ISSN: 2348-6848
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probability value of 0.03 was less than 0.05 set as bench mark, the null hypothesis (H_{01}) was rejected. Inference drawn therefore is that, there is a significant difference in the mean conceptual change score of students taught electrochemistry using5E's learning cycle andcomputer assisted instruction with those taught withcomputer assisted instruction performing better than those taught using 5E's learning cycle.

Research Question 2:

What is gender influence on students' conceptual change in electrochemistry when taught using the 5E's learning cycle and computer assisted instruction?

Table 3: Mean and Standard Deviation of male and female students pretest and posttest conceptual change scoresof5E's learning cycle and computer assisted instruction groups

			Pretest		**Posttest**		
Instructional Approach	Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean Gain
5E's L. C	Male	51	18.02	8.02	41.55	15.59	23.53
	Female	30	18.00	11.73	38.30	10.69	20.30
C. A. I	Male	50	26.56	10.47	48.50	11.83	21.94
	Female	37	22.05	10.26	47.51	13.22	25.46

Result on Table 3 shows the influence of gender on mean students' conceptual change score in electrochemistry using 5E's learning cycle and computer assisted instruction. Results show that the teaching of electrochemistry using the 5E's learning cycleinfluenced the males (with a mean difference of 23.53) more than the females (with a mean difference of 20.30) on conceptual change in electrochemistry. On the other hand, the teaching of electrochemistry with computer assisted instruction influenced the females (with a mean difference of 25.46) more than the males (with a mean difference of 21.94) on conceptual change in electrochemistry as shown on Table 3

Ho_2: There is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry with the 5E's learning cycle and those taught with computer assisted instruction.

Table 4: Analysis of Covariance (ANCOVA) results showing effects of strategies and their interaction on students' conceptual change

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	7820.736[a]	4	1955.184	13.541	.000	

International Journal of Research
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 08 Issue 02
February 2021

Intercept	30818.140	1	30818.140	213.473	.000	
Pretest	5091.127	1	5091.127	35.360	.000	
Strategies	760.572	1	760.572	5.267	.23	
Gender	28.612	1	28.612	.198	.657	NS
Strategies/Gender	225.221	1	225.221	1.560	.213	NS
Error	24608.059	165	149.140			
Total	361817.000	168				
Corrected Total	31356.280	167				

The result on Table 4 shows that with respect to mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction, an F-ratio of 0.198 was obtained with associated probability value of 0.65. Since the associated probability value of 0.65 is greater than 0.05 set as bench mark, the null hypothesis (H_{02}) was upheld. This indicates that male and female students did not have significant difference in conceptual change in electrochemistry when exposed to the two strategies. Inference drawn therefore is that, there is no significant difference in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cycle andcomputer assisted instruction.

Hypothesis 3

H0$_3$: There is no significant interaction effect of the instructional strategies and gender on students mean conceptual change scores in electrochemistry.

The result on Table 4 shows that with respect to the interaction effect of the instructional strategies and gender on the mean conceptual change scores of students taught electrochemistry, an F-ratio of 1.560was obtained with associated probability value of 0.21. Since the associated probability value of 0.21 is greater than 0.05 set as bench mark. The null hypothesis (H_{03}) was upheld. Inference drawn therefore is that, the interaction effect of strategies and gender on the mean conceptual change scores of students taught electrochemistry is not statistically significant.

Discussions of Findings

Effect of using 5E's learning cycle and computer assisted instructionon students' conceptual change in electrochemistry.

The result of the study as presented on Table 1 shows that the group taught electrochemistry using computer assisted instruction had a higher conceptual mean gain (23.42 > 22.34). This means that computer assisted instructionbrought about students' conceptual change in electrochemistry more than5E's learning cycle.Results from the test of hypothesis one shows that there was a significant difference in the mean conceptual change score of students taught electrochemistry with5E's learning cycle and computer assisted instruction with those taught with computer assisted instruction performing better than those taught with 5E's learning cycle.

The observed difference could be connected to the type of activities the students were engaged in. Students in the computer assisted instruction watched the concept under study in a computer with the help of colourful animated models of the concept. These animations may have made electrochemistry which is an abstract concept to the student more concrete. Students' watched the movements of ions and other reactions in a computer. This result agrees with Dewey, Brunner, Piaget and Vygotsky who maintained that knowledge is constructed by the individual learners and is embodied in human experience, perceptions, imaginations and mental and social constructions. The removal of students' misconceptions in electrochemistry and bringing about conceptual change will improve students' deep understanding of the concept and hence its application to meet societal needs. The result of this study therefore shows thatthe use of Computer Assisted Instruction in teaching the students tend to improve students' conceptual change more than the instructional package without Computer Assisted Instruction (CAI).

Influence of Gender on Students' Conceptual Change in Electrochemistry

The result of the study as presented in Table 5 shows the influence of gender on students' conceptual changein electrochemistry. Results show that in all cases, the posttest mean conceptual change scores were greater than the pretest mean conceptual change scores with the male students having a higher conceptual change mean gain when taught using 5E's learning cyclewhile the female students had a higher conceptual mean gain when taught using computer assisted instruction. However, the result from the test of hypothesis three shows that there was no significant difference ($p>0.05$) in the mean conceptual change scores of male and female students taught electrochemistry using 5E's learning cyclemodel andcomputer assisted instruction. This means gender is not a significant factor in determining students' conceptual change in electrochemistry. This result disagrees with the result of Okonkwo (2012) who researched on the effect of concept mapping and simulation game teaching strategies on students' achievement and interest in environmental concept in chemistry. The author noted that male students achieved more than the females. The result of the present study also disagrees with Agomuoh (2010), who studied the influence of gender on students' conceptual change and noted that there was a significant difference in the conceptual change of males and females students in favour of the male students. Contrary to the findings above, some studies found girls more superior in the sciences than boys. This include the research by Ekwueme and Umoinyang (2005). The result showed that girls had better attitude towards mathematics than boys. The findings of this study are similar to the findings of Gyuse, Achor and Chianson (2015). The authors discovered that there was no significant difference between mean creativity level of male and female students. This result is also in line with the findings of Miriogu (2012) who discovered that there was no significant difference in the achievement of male and female students. The insignificant difference in the mean conceptual change scores of male and female students taught electrochemistry with5E's learning cycleandcomputer assisted instruction was due to the fact that the treatments male and female students received gave them equal opportunities. Both strategies helped male and female students to have sound theoretical and

practical knowledge in electrochemistry. Such knowledge will enable them to participate in solving local and national problems.

Interaction Effect of Instructional Strategies and Gender on Students' Conceptual Change in Electrochemistry

The result in table 6 revealed that there was no significant interaction effect of strategies and gender on students' mean conceptual change in electrochemistry. This means that the strategies did not have different effects on the students' (males and females) conceptual change. Hence, conceptual change exhibited by males and females in the 5E's learning cycle and computer assisted instruction groups were mainly due to treatment irrespective of gender. Hence, strategies used did not combine with gender to affect students' conceptual change. This result disagrees with Adegoke (2011) who found a significant interaction effect between treatment and cognitive style preference. This result also disagrees with the findings of Orji (2014) who noted a significant interaction effect of school location, gender and instructional treatments to foster conceptual change in the students. However, the findings of the study is similar to that of Oladejo, Olosunde, Ojebisi and Isola (2011) who noted that there was no significant interaction effect of treatment and gender on students' achievement in physics. The absence of interaction effect of method and gender on students' conceptual change in this study could be attributed to the fact that instructional methods used provided equal opportunities for all the students irrespective of their gender. Both male and female students were provided with equal environment to operate and this environment was gender friendly and benefited all the students.

Conclusion

The findings of the study, revealed that 5E's learning cycle and computer assisted instruction improved students' conceptual change in electrochemistry. However, computer assisted instruction improved students' conceptual change in electrochemistry more than 5E's learning cycle. Also, there was no significant difference in the conceptual change of male and female students taught electrochemistry with 5E's learning cycle and computer assisted instruction. Finally,the interaction effect of strategies and gender on conceptual change of students taught electrochemistry was not statistically significant. This indicates that gender did not combine with the strategy used to affect conceptual change. Hence, conceptual change of the concept under study by students was due to the treatment.

Educational Implications of the Findings

The findings of this study have shown that students have misconceptions in electrochemistry. Therefore, constructivist based instructional strategies such as computer assisted instruction can repair these misconceptions thereby bringing about conceptual change in electrochemistry.

Recommendations

On the basis of the findings of this study, the following recommendations are made.

The finding of the study showed that computer assisted instruction improved students' conceptual change more than5E's learning cycleinstructional strategy in electrochemistry. It is therefore recommended that chemistry teachers should be trained and retrained on how to use thisstrategy in teaching chemistry concepts.

The school administrators should always organize workshops for chemistry teachers especially in areas of pedagogy. Knowledge from the workshop will help the chemistry teachers in identifying the best conceptual change strategies that would help in eliminating students' misconceptions in electrochemistry. Such awareness of students' misconceptions and how to eliminate them would enable the teachers' to adjust their teaching patterns in order to eliminate students' misconceptions irrespective of students' gender.

Suggestions for Further Studies

Based on the findings of the study, the following suggestions were made for further research.

1. A replication of the same study can be done in other Local Government Areas and states of the federation.
2. Further investigations should be carried out using larger sample size and in geopolitical zones of the country.
3. Another study should be conducted on the effect of computer assisted instruction and 5E's learning cycle on students' conceptual change in other concepts in chemistry as well as other subjects.

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