

Effect of Problem-Based Learning Method on Pupils' Academic Achievement in Mathematics in Awka South Local Government Education Authority

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Abstract:

The study investigated the effect of problem-based learning method on pupils' academic achievement in mathematics in Awka South local government education authority. The study was guided by two research questions and two hypotheses were tested at 0.05 level of significance. Quasi-experimental pre-test, post-test non-equivalent control group research design was adopted for the study. The population of this study comprised all the 2,377 basic five pupils in Awka-South Local Government Education Authority. Simple random sampling technique was used to draw the sample size of 92 basic five pupils for the study. The instrument titled "Mathematics Achievement Test (MAT)", validated by three experts with a reliability coefficient of 0.72 was used for data collection. Mean and standard deviation were used to answer the research questions and ANCOVA was used to test the hypotheses. The findings of the study revealed among others that the difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM) is in favour of experiential group. It was also reported that there was significant difference in the mean achievement scores of pupils taught mathematics using PBLM and those taught using CTM. Based on the findings, it was recommended among others that Anambra State Universal Basic Education Board should encourage and support teachers to use problem based learning method for teaching Mathematics to pupils. Then workshops should be organized for mathematics teachers to familiarize them with the use of PBLM.

Keywords: *Problem-Based Learning, Pupils, Academic Achievement, Mathematics*

1.1.INTRODUCTION

Education is one of the priority sectors for every well meaning society. It is an instrument for acquisition of requisite skills and knowledge for national development. Md-Esahaque (2017) noted that education is the most powerful instrument of social change and national development. The elementary stage of education which a child passes through is considered one of the important educational processes for effecting national development and survival in a constantly changing world. Primary education is perceived as one of the most challenging and yet important transition period in a child's life. The level of learners' success at primary school lays solid foundation for progress into other levels of education. There are many subjects offered in primary schools in Nigeria.

The subjects offered at the basic education level in Nigeria include; English Language, Mathematics, one major Nigerian Language (Hausa, Igbo or Yoruba), Basic Science and Technology, Religious and National values Education, Cultural and Creative Arts among others (Moyinoluwa, 2015). Mathematics is one of the key and foundational subjects taught at different levels of education starting from the pre-primary school to the primary and secondary levels and even beyond.



The concept of Mathematics has variously been interpreted by scholars. Mathematics is a branch of information which is centred on estimations, numbers and amounts (Wachikwu, Oyovwe, Magnus-Arewa & Nwachukwu, 2017). According to Thompson (2014), Mathematics is a subject that teaches critical thinking and problem-solving in a much applied form. Thompson further stressed that the study of mathematics application adds practical value in life like; generating everyday living, counting notation, addition, subtraction, multiplication, division, weighing, measuring, selling and buying. Malik, Rifaqat and Hifsa (2018) defined Mathematics as a subject that promotes logical thinking and provide us tools to describe abstract ideas in quantitative terms and intelligent fashion. In the context of this study, mathematics is defined as a subject that promotes logical thinking and exploration of numerical figure in solving a problem. The study of Mathematics has numerous benefits.

Mathematics is an aid to representing and attempting to resolve situation in all disciplines. Its function and relevance to education and the society makes it to be regarded as the bedrock of science and technological development. In a broader sense, the Federal Republic of Nigeria in the National Policy on Education (FRN, 2013), emphasized that mathematics is a compulsory subject taught starting from the pre-primary, primary to secondary levels of education in Nigeria. In this light, FRN added that the general objective of primary education is to generate interest in mathematics for everyday living. Counting notation, addition, subtraction, multiplication, division, weighting, measuring, selling and buying are some of the simple and fundamental processes of mathematics which have practical value in life. In view of this, Ogan (2012) argued that no nation can develop scientifically and technologically without proper foundation in mathematics.

Despite the recognition accorded to mathematics and its benefit in nation building, its teaching in basic schools in Anambra State appears not to be effective as pupils consistently achieve poorly in their Basic Certificate Examinations. Reports from the Anambra State Universal Basic Education Board (ASUBEB, 2017) revealed that the academic achievement of pupils in core subjects especially mathematics has been decreasing various years. In 2015, the number of pupils that registered for the subject was 67,894 out of which 36,595 (53.9%) failed. In 2016, 63,876 pupils registered for the subject out of which 33,390 (52.3%) failed. Similarly, in 2017, out of 70,208 pupils who registered for the subject, 31,140 (52.9%) pupils failed. Several factors have been implicated on low academic achievement of pupils in primary school core subjects especially mathematics. Persistent drop in the academic achievement of pupils in mathematics may be hinged on several factors which includes negative attitude of government and society towards core subjects, lack of relevant instructional material in schools, poor quality teachers and their teaching methods and pupils' poor study habits. Of all these factors, teachers and their teaching methods appear to have the highest impact on academic achievement of pupils in Mathematics. This is because a good teacher will select and use teaching methods that enhance active participation of students in class activities in Mathematics to ensure high academic achievement. Among the factors implicated in pupils' poor achievement in mathematics is the teachers' teaching method. There is need to seek for innovative methods of teaching mathematics that could enhance pupils' academic achievement in the subject.



Academic achievement is defined as the outcome of a student's learning in a given school subject. Academic achievement has been defined by Okoro, (2011) as the scholastic standing of a student at a given moment, which states individual abilities. It is a measure of the extent to which a pupil, teachers or institution has achieved the set educational goal or goals. Academic achievement in this study is defined as the learning outcome which indicates the level of mastery, proficiency and knowledge shown by an individual after learning has taken place.

Pupils' academic achievement can be explained in terms of grades obtained from tests or examinations on courses taken. Academic achievements of pupils respond to a series of variables like teaching methods. Ajoma (2009) defined teaching method as a professional technique teachers adopt regularly in instructional exercises to enable them impart relevant knowledge and skills to the learner. Efanga (2014) averred that for any subject to be effectively taught, teachers have to select appropriate teaching methods that will appeal to both male and female students, arouse their interest and enable them achieve excellent performance. When a concept is taught with a teaching method suited for it, learning increases. On the contrary, wrong method of teaching yields poor academic achievement of the learners. Teaching methods refer to the process of transmitting facts, skills, information and knowledge by the teacher, so as to engage students in meaningful activities for learning and to achieve the objective of the lesson. One of the teacher-centred methods is what this study considers as the conventional teaching method.

Conventional method of teaching is viewed as an oral presentation of information to pupils without an active involvement or effort on the part of the pupil. Ajoma (2009) stressed that the advantages of conventional teaching method is that suitable for covering large number of course contents with minimum time interval. On the contrary, Ajoma added that it fails to stress how teacher structure guided teaching to facilitate pupils' critical thinking, enhance interactive class sessions, and constructive behaviour which could be considered as one of the teaching objectives of modern method of teaching. This method of teaching therefore might not be capable of producing skills required by students to cope with challenges of rapid economic and technological development. Ato and Adelaide (2015) pointed out that Mathematics educators are calling for reforms that will inculcate into pupils the habit of problem solving and also be able to apply mathematics to daily activities. One of the students' activity-based teaching methods is problem-based learning method.

Problem-based teaching method (PBLM) is an educational instructional method that fosters learning and the development of 21st century competencies and skills through problem solving and the integration and application of knowledge in real-world settings (Capraro & Slough, 2013). Gustin, Abbiati, Bonvin, Gerbase and Baroffio (2018) defined problem-based learning method as a pupils-centred learning method in which pupils discuss issues, reactivate their previous knowledge and construct coherent explanations of the problem. Operationally, PBLM is one of the modern methods of learning that involves pupils' ability to think critically, analyze and solve complex real world problems.

In the PBLM procedure, pupils are placed into small groups and presented with an open-ended problem to solve or question to answer (child centred). These problems are designed to activate and build upon prior knowledge, and are almost always related to real-world scenarios. Sarvey (2010) defined PBLM as an instructional and curricular learner-centered approach that



empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. Sarvey also suggested that current and future generations of pupils are vitally important to experience a problem-based learning approach and engage in constructive solution-seeking activities.

PBLM mainly highlights its concepts to the students by means of challenges in the form of problems relevant to their future practice (Woods, 2010). Instead of using a rigid lesson plan that directs a learner down a specific path of learning outcomes or objectives, problem-based learning allows in-depth investigation of a topic worth learning more about. In addition, the PBLM not only help to maintain pupils' interest but also motivate them to take more responsibility for their learning irrespective of their gender.

Gender is a term which describes behaviour and attributes expected of individuals as the basis of being either males or females in a given society (Oludipe, 2012). Certain professions have traditionally been regarded as men's (medicine, engineering, architecture) and others women's (Nursing, Catering, Typing, Art) (Oludipe, 2012). However, there has been conflicting findings on how gender influences academic achievement. It seems the influence of gender varies according to school subjects. For instance, a study carried out by Kolawole (2007) revealed that male students performed better than female pupils in the cognitive, affective and psychomotor skill achievements while Abubakar and Adegboyega (2012) reported that gender was insignificant in the academic achievement of pupils in mathematics in Ogun State. Males and females adapt differently to different teaching methods, strategies and approaches. This kind of situation therefore calls for continuous research works on gender and academic achievement. Thus, this informed this study to investigate the effect of PBLM on male and female pupils' academic achievement in mathematics.

Teaching method could have significant effect on the gender of students in schools pertaining to their achievement. Teacher-centered method allows a great deal of information to be passed to the learner. In spite of this advantage, the teacher-centered method does not stimulate students' innovation, inquiry, self discovery and scientific attitudes. It aid retention of facts that could be easily forgotten. It has therefore become apparent that the teacher-centered method which is currently the predominant teaching approach in Nigerian primary schools needs to be buttressed with learner-centered method for effective achievement of the objectives of mathematics. There is, therefore, a need to search for more effective methods which are suitable and efficient for promoting the level of primary school mathematics achievement beyond contemporary limits and to the satisfaction of the current mathematics curriculum requirements. Upon this background, the study sought to investigate the effect of problem-based learning method on pupils' academic achievement in mathematics in Awka south Local Government Education Authority.

1.2 Statement of the Problem

The ideal situation is that pupils should perform well in mathematics as a compulsory subject through the application of appropriate teaching method because it is one of the core subjects that pupils must pass in their common entrance examination for the award of first school leaving certificate. Their basic knowledge however, about mathematics will help them fit in during

mathematics class when they transit to secondary school. There seems to be unsatisfactory academic achievement of pupils in mathematics which has posed concern to parents, teachers, educational administrators and government for years.

The unsatisfactory academic achievement among pupils in mathematics keeps persisting for years. For instance, the summary result of pupils' common entrance examination in five selected schools in Awka-South Local Government Authority from 2012/2013–2016/2017 session revealed that the highest percentage pass of pupils' achievement in mathematics is 44.05%. This means that virtually all the selected schools in five consecutive years failed mathematics woefully. One may suspect that the unsatisfactory academic achievement may be attributable to the conventional teaching method often employed by the teachers in teaching mathematics despite its succinct advantage for teaching large classes. The researcher is worried that if the method of teaching and learning mathematics remains as it is presently, pupils in Anambra State primary schools may continually lag behind. It is against this backdrop that the researcher seeks to investigate the effect of problem-based learning method on pupils' academic achievement in mathematics in Awka South Local Government Education Authority.

1.3 Purpose of the Study

The purpose of the study is to ascertain the effect of problem-based learning method on pupils' academic achievement in Mathematics in Awka South Local Government Education Authority. Specifically, the study sought to determine the:

1. The difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM).
2. The difference in the pretest and posttest mean scores of male and female pupils taught mathematics using PBLM.

1.4 Research Questions

The following research questions guided the study.

1. What is the difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM)?
2. What is the difference in the pretest and posttest mean scores of male and female pupils taught mathematics using PBLM?

1.5 Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM).
2. There is no significant difference between the mean achievement scores of male and female pupils taught mathematics using PBLM.



2.Method

The design of the study was quasi-experimental design. Nworgu (2015) defined quasi-experimental research design as an experiment where random assignments of subjects to experimental and control groups are not possible. This research design is considered suitable because the researcher manipulated the variables under carefully controlled conditions so that the effects of these manipulations could be observed without random assignments of subjects to experimental and control groups. The study was carried out in Awka-South Local Government Area of Anambra State. The population of this study comprised all the 2133 respondents made up of 1050 male and 1083 female basic five pupils in Awka-South Local Government Education Authority. Simple random sampling technique was utilized to draw a sample size of 92 basic five pupils. From the experimental school, the whole intact class was used (23 males and 25 females given a total of 48 pupils). From the control group school, the whole intact class was used (19 males and 25 females given a total of 44 pupils).

The instrument used for data collection in this study was Mathematics Achievement Test (MAT). The instrument was developed by the researcher using First School Leaving Certificate standardized tests of 2017, 2016, 2015 and 2014. The content validity of the Mathematics Achievement Test (MAT) was established using three experts. The MAT which had a total of 15 objective test items and lesson notes were given out together with the title of the study, purpose, research questions and hypotheses to three experts who were asked to check whether the items were relevant, adequately covered the contents, had acceptable level of difficulty, whether the language was ambiguous and ideas were not repeated. All their Corrections, recommendations and suggestions were diligently done before the researchers could come up with the final copy of the instrument to be used for the study. The MAT was administered among 30 basic five pupils in two selected primary schools in Onitsha North Local Government education Authority outside the research area which has a homogenous culture as the research area. The scores for MAT obtained from trial testing exercise carried out with 30 basic five pupils were used to estimate the reliability coefficient of the instrument using Kuder Richardson Formular (KR-20) which yielded a reliability of 0.72. This value was considered adequate by the researcher as this was in agreement with Ogundare (2008) that any figure above 0.70 is an acceptable reliability value.

Pre-test and post-test were administered to all the pupils in both the experimental group and the control group before and at the end of the treatment. Answer sheets were distributed to the pupils along with the question papers (containing 15 items) for their responses. The test lasted for 45 minutes after which answer sheets were retrieved for marking and scoring. Each item on the question carries one mark to make a total of 15 marks. The researcher briefed the participating mathematics teachers (also the research assistants) who taught the pupils using problem-based learning method. This visitation was done two weeks before the commencement of the treatment. The researcher visited the experimental group school teacher at the appropriate time as agreed in order not to disrupt the school normal activities. To control the initial differences of subjects in these intact classes, Analysis of Covariance (ANCOVA) was employed for data analysis. In order to avoid such experimental bias in the study, the regular mathematics teachers in the two schools under the study was briefed as research assistants and used. Pre-test

sensitization was controlled in this study through a longer time interval of five weeks between the pre-test and post-test. These tests demand much more than recall information in that it emphasizes comprehension and application. To control this internal validity threat, the items in the instrument were renumbered and reshuffled to minimize the ability of the pupils realizing that they were being re-tested. Data obtained through MAT were analyzed with mean and standard deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used to test all the hypotheses at 0.05 level of significance. In the test of hypothesis using ANCOVA, F ratio value was used to determine the acceptance or rejection of the hypotheses. The null hypothesis was rejected if p-value is less than the level of significance (0.05), if p-value is greater than or equal to 0.05, null hypothesis was not rejected. In statistical significance testing, p-ratio value is the probability of obtaining a test statistics at least as extreme as the one that was actually observed, assuming that null hypothesis is true.

3. Results

Research Question 1: What is the difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM)?

Table 1: Mean Pre-test and Posttest Mean Achievement Scores of Pupils taught Mathematics using PBLM and those taught using CTM

Method	N	Pretest Mean	Posttest Mean	Mean Gain	Pretest SD	Posttest SD
PBLM	48	24.27	79.65	55.38	3.39	2.69
CLM	44	20.68	49.55	28.87	4.08	4.55

Table 1 shows that the pupils taught mathematics using PBLM has mean gain achievement score of 55.38 while those taught using CTM has gain in mean achievement score of 28.87. The spread of score was higher in the posttest mean of those taught using PBMT, than the spread of scores in the mean post-test of those taught using CTM. The difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM) is in favour of experiential group.

Research Question 2: What is the difference in the pretest and posttest mean scores of male and female pupils taught mathematics using problem-based learning method (PBLM)?

Table 2: Mean Pre-test and Posttest Mean Achievement Scores of Pupils taught Mathematics PBLM

Gender	N	Pretest Mean	Posttest Mean	Mean Gain	Pretest SD	Posttest SD
Male	23	22.61	81.22	58.61	2.43	3.67
Female	25	25.80	78.20	52.40	2.22	4.30

Table 2 shows that the male pupils taught mathematics using PBLM has mean gain achievement score of 58.61 while the females has gain in mean achievement score of 52.40. The spread of

score was higher in the posttest mean achievement scores of the female pupils than it was in the posttest mean achievement scores of the male pupils as shown by their standard deviation. The difference in the pretest and posttest mean scores of male and female pupils taught mathematics using problem-based learning method (PBLM) is in favour of female pupils.

Hypothesis 1: There is no significant difference in the mean achievement scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM).

Table 3: ANCOVA on Difference between the Mean Achievement Scores of Pupils taught using PBLM and those taught using CTM

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	20799.665 ^a	2	10399.833	481.177	.000	
Intercept	75743.951	1	75743.951	3504.504	.000	
Pretest	.303	1	.303	.014	.906	
Method	20297.516	1	20297.516	939.121	.000	S
Error	1923.585	89	21.613			
Total	414419.000	92				
Corrected Total	22723.250	91				

Table 3 shows that at 0.05 level of significance, 1df numerator and 91 df denominator, the calculated F is 939.121 with P-value of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference in the mean achievement scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM).

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female pupils taught mathematics using PBLM.

Table 4: ANCOVA on Difference between the Mean Achievement Scores Male and Female Pupils taught using PBLM

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	118.074 ^a	2	59.037	2.904	.065	
Intercept	54712.248	1	54712.248	2691.045	.000	
Pretest	9.008	1	9.008	.443	.509	
Method	98.288	1	98.288	4.834	.033	S
Error	914.905	45	20.331			
Total	305519.000	48				
Corrected Total	1032.979	47				

Table 4 shows that at 0.05 level of significance, 1df numerator and 47 df denominator, the calculated F is 4.834 with Pvalue of .033 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is significant difference between the mean achievement scores of male and female pupils taught mathematics using PBLM.

4. Discussion

It was found out that the difference in the pretest and posttest mean scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional teaching method (CTM) is in favour of experiential group. This is an indication that pupils taught Mathematics taught using PBLM performed better than those taught using CTM. This affirmed the finding of Abdu-Raheem (2012) which indicated that learners taught using problem solving method had higher adjust post-test achievement score than those taught using conventional method. The possible explanation for the similarity in the findings is that the two studies were conducted in Nigeria where similar teaching method is applied across the country. This also corroborated the finding of Etokerem, Ibemenj and Alamina (2019) which revealed that learners exposed to problem-solving teaching obtained higher score in achievement test than those in conventional teaching method. The agreement in the two findings could be attributed to time span as the two studies were conducted in the same year. Better academic achievement of pupils taught Mathematics using problem based learning method than those conventional method was found out probably because PBLM provides opportunity for pupils to reconstruct and reorganize information in finding solution to geometry problems in Mathematics. The possible explanation for the finding is that problem solving teaching method makes learning an active process, where the pupils immensely contribute during instruction. The teaching method helps pupils to approach Mathematical problems to be learnt with the spirit of inquiry, competition and interest instead of memorization which is a common feature of conventional teaching method.

It was also reported that there is significant difference in the mean achievement scores of pupils taught mathematics using problem-based learning method (PBLM) and those taught using conventional method (CTM). This is in line with the finding of Ajai, Imoko and O'kwu (2013) which showed that learners taught using PBL achieved significantly higher in the post test than those taught algebra using conventional method. This is also supported the result of Malik, Rafiqat and Hifsa (2018) who reported that among others that there was significant difference between the achievement scores of learners taught Mathematics using problem solving method and those taught using conventional teaching method. This was further in line with finding of Fatoke, Ogunlade and Ibidiran (2013) which indicated that there was a significant difference in the academic performance of those learners exposed to problem-solving instructional strategy and those exposed to conventional method. The possible explanation for the finding is that problem solving teaching method is enjoyable as it allows pupils to work at their pace and make decisions about the way they explore the problem.

The finding of the study revealed that the difference in the pretest and posttest mean scores of male and female pupils taught mathematics using problem-based learning method (PBLM) is in favour of female pupils. This shows that female pupilstought mathematics using problem-based learning performed better than their male counterparts. This is in disagreement

with the finding of Etokerem, Ibemenj and Alamina (2019) who reported that male learners taught using problem-solving method recorded higher mean academic achievement scores than female students. The disagreement in the two findings could be attributed to fact that the two studies were conducted in the different geographical location. However, the finding is an indication that male and female pupils have equally learning opportunity and the problem based method applied by teachers could affect their academic achievement in Mathematics. This may show that female pupils are more likely to solve geometry problems in Mathematics when exposed to problem based learning, while the male pupils counter seem to prefer less problem-solving tasks even when they are taught with the same method.

Further finding indicated that there is significant difference between the mean achievement scores of male and female pupils taught mathematics using PBTM. This is in agreement with the findings of Etokerem, Ibemenj and Alamina (2019) who reported that there was significant difference between male and female learners taught using problem-solving method. The reason deduced from the disparity was that mathematics is practices and skills oriented which seems to inclined to females than males because of the former masculine nature that could make them prefer physical demanding tasks.

5. Conclusion

Based on the findings of this, it is concluded that problem solving learning method has significant effect on pupils' academic achievement in Mathematics. It is an effective method of teaching Mathematics. It was also found to be more effective than conventional method of teaching Mathematics. Male and female pupils significantly differed in their academic achievement when taught mathematics using PBLM in favour of experimental group.

6. Recommendations

In line with the findings of the study, the following recommendations were made by the researcher:

1. Mathematics teachers should be encouraged to use problem-based learning method, since it is effective for teaching mathematics to pupils in basic five.
2. Anambra State Universal Basic Education Board should encourage and support Mathematics teachers to participate in national or international conferences outside the shores of Nigeria in order to acquit themselves with knowledge of use of problem solving in instructional delivery in the school system.
3. Headteachers should regular visit the classroom to observe and guide teachers in the use of problem solving method during Mathematics Lesson.

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