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Science Education in Kenyan Secondary Schools: A Gender Perspective

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Abstact

Science Education is practical, which equips students with concepts and skills that are useful in solving the day-to day problems of life. The study of science subjects aims at providing the learner with the necessary knowledge with which to control or change the environment for the benefit of an individual, family or community. However, the secondary school students' performance in these subjects in the Kenya Certificate of Secondary Education (KCSE) in NYAMIRA District has been quite low over the years. The public outcry and concern by parents, teachers, educationists and students about mass failure in science subjects and mathematics in national examinations is a clear indication that factors influencing student's performance in these subjects need urgent investigation. The aim of this study was to investigate the effect of gender, attitude, and science anxiety on performance of secondary school students in science subjects in secondary schools. The Cross-sectional descriptive research design was employed in this study. Nine (9) secondary schools were randomly selected for study out of 139 schools in NYAMIRA district. Different categories of schools were used depending on the school set-up and these are (i) Single- gender boys boarding schools (ii) Single- gender girls boarding schools (iii) Single- gender girls day schools (iv) Co-educational boarding schools (v) Co-educational day schools (vi) Co-educational boarding / day schools. Co-educational schools were considered to reduce possible biases. A total of three hundred and sixty (360) form three students were randomly selected for the study. A student questionnaire (SQ) and a teacher questionnaire (TQ) were used as the instruments for data collection. Data collected were analyzed using descriptive statistics. The study established that boys perform better than girls in science subjects. The study also found that students of both genders had a positive attitude towards the learning of science subjects, but boys had a relatively more positive attitude than girls. Girls were also found to have a higher level of science anxiety in the learning of sciences compared to the boys. This study was expected to significantly contribute in the provision of information that could be used by teachers, parents, educationists and policy makers to improve on the teaching, learning and performance of students in science subjects. The findings of the study are expected to contribute immensely both theoretically and practically to the effective teaching and learning of sciences at secondary school level. The findings of the study will also be of fundamental importance to policy makers and educationists in regard to science education.

Introduction

Science Education since the very earliest times in the history of man has been of tremendous value to society all over the world (Orodho, 1996). It has ensured conformity, stability and continuity in society globally. According to Hawes (1979), the late 1960's saw the planning and development of new science syllabuses in the United States of America and Britain after the launching of the Sputnik by Russians in 1957. In the early 1960's an American science curriculum project, they mainly focused on biological sciences. The Biological Sciences Study Committee (BSSC) was formed. The preparation of the biology curriculum was based on the British Nuffield science courses. In

developing the Nuffield courses, American materials were used. In particular, the Nuffield Science projects in England required understanding of scientific concepts through experiments using a Chinese proverb: "I hear and I forget, I see and I remember, I do and I understand". These curriculum developments spilled over into developing countries in Africa in the early 1970's. The introduction of highly sophisticated and expensive scientific and technological education for the developing African states was done without regard to laying foundations in secondary schools for fundamental growth of knowledge, skills and attitudes necessary for understanding them. The importation of science curriculum packages into Africa had far reaching repercussions on the development and implementation of science subjects like biology, physics, chemistry and mathematics at secondary school level in Kenya from that time to-date.

In East Africa, the Secondary Science Project (SSP) was supported by an organization in Britain called the Curriculum Research and Development Overseas (CREDO). This organization was later renamed the Centre for Educational Development Overseas (CEDO) and it became part of the British Council (Hawes, 1979). The SSP biology course has since been amalgamated with the traditional biology course to form the new biology course for all secondary schools. The basis for science curriculum development was the 'unit', an inquiry topic that was used in any order and at more than one level. The output of writing workshops owed a great deal in style and organization to the Education Development Centre (EDC) in America. The birth of Science Education
Programme for Africa (SEPA) in 1969 saw the establishment of science curriculum development centre at the Kenya Institute of Education (K.I.E). SEPA's role was originally seen as a "clearing house" for exchanging ideas and information about science curriculum development and as a means of supporting and strengthening national bodies in member states in their efforts towards improving the learning of science subjects. Under this effective direction, it extended its interests and influence in evaluation, child development and the relationship between materials and approaches in teaching science subjects (Hawes, 1979).

Since 1963 at independence, the education system in Kenya has undergone fundamental changes. The main reason why the Government of Kenya decided that science and technological subjects be taught in schools was the recognition of the important role, science and technology education play in the economic, social and industrial development (Republic of Kenya, 1972). The Government of Kenya also spends over 30% of the annual budget on education (Republic of Kenya, 1989). Eshiwani (1993) observed that a large proportion of this money is channeled towards the improvement of science education. However there is no evidence that this increased expenditure has necessarily been associated with improved performance in science subjects on the part of the learners at the secondary school level (SMASSE Project, 2013).

In Kenya many science teachers are at present experiencing considerable disquiet as a result of the demands made on them, and the various strategies advocated. In recent years a spirit of change and innovation has pervaded science education activities in this country. Science education has been in a lot of lime light, for example the project called Strengthening of Mathematics and Sciences in Secondary Education (SMASSE), which was initiated by the Ministry of Education to provide in-service refresher training for science and mathematics teachers. In the SMASSE in-service training, teachers are given information that is integrated with hands-on activities and inquiry that assists teachers to have more interest and less anxiety when teaching. The teachers are expected to practice this in the classroom by maximizing the use of teaching aids and engaging learners in "hands-on" experiences in the course of the teaching-learning process. The public outcry and concern by parents, teachers, educationists and students about mass failure in science subjects and mathematics in national examinations is a clear indication that factors influencing student's performance in these subjects need urgent investigation (Moseti, 2014).
The Government of Kenya has particularly felt a need to improve the science education it offers so as to build up a knowledgeable manpower required for its industrial and technological transformation (Republic of Kenya,

1999; SMASSE Project, 2013). In this regard, existing practices must be reviewed from time to time in the light of new development and changing requirements. In Kenya today, the most dominant feature of the education system is academic performance (Chepchieng, 1995). As such explanations for good and poor student academic performance have been exhaustive, yet controversy still exists among scholars as to what contributes singly or jointly towards students' poor performance (Chepchieng, 1995). Educationists and researchers have the predominant belief that school variables which include teacher qualifications, class size, availability of learning resources and school administration play a more critical role in educational achievement than other variables (Chepchieng, 1995). Changeiywo (2013) also gives us an insight into the reasons why learners perform poorly in science subjects; he suggests the following reasons: inadequate time allocated for learning science satisfactorily, inadequate instruction material, low level and inadequate training of teachers, the nature of the science curriculum-it is highly abstract and seems irrelevant to the learners' immediate environment. This leads to the learner's negative attitude towards science.

In NYAMIRA district the essential elements have been an emphasis on science and technical subjects. Different methods of teaching are being used by science teachers, with the hope to optimize learning on the part of the learners. An improved instructional technology is making inroads in the school system and institutions are of a new kind, intended to make learners achieve higher (SMASSE Project, 2013). A study of this kind also draws importance from the fact that achieving the aims of industrialization can be jeopardized if a large proportion of anticipated beneficiaries do not have adequate access to appropriate kinds of education and training in science.

Statement of the Problem

The performance of students in science subjects in the Kenya Certificate of Secondary Education (KCSE) has been unsatisfactory over the years in many secondary schools in the country (KNEC, 2013). In NYAMIRA District, the performance has been lower than expected in this subjects as indicated by records from the District Education Office. This has caused a lot of concern about the performance in science subjects and mathematics (KNEC, 2013). Studies focusing on the impact of gender, attitude, and science anxiety on performance in biology at secondary school level are not well conceptualized. This lack of sufficient knowledge regarding these factors and their influence would militate against the country's aspiration to achieve the 'Vision 2030' and the Global Millennium Goals (GMGs). This is because science subjects are key in the contribution towards industrialization, environmental conservation, medical research, food management and improved agricultural production.

Purpose and Objectives of the study

The purpose of this study was to determine the influence of the gender, attitude and science anxiety of the students on their performance in science subjects at the secondary school level in NYAMIRA District.The specific objectives of this study were to:

(i) To investigate the influence of the students' gender on performance in sciences at secondary school level in NYAMIRA District.
(ii) To investigate the influence of students' attitude on performance in sciences at secondary school level in NYAMIRA District.
(iii) To investigate the influence of students' science anxiety on performance in sciences at secondary school level in NYAMIRA District.

Research Questions

The study addressed the following research questions:

(i) What is the influence of students' gender on performance in science subjects?
(ii) What is the influence of students' attitude on performance in science subjects?
(iii) What is the influence of students' science anxiety on performance in science subjects?

Conceptual Framework

The conceptual framework used in this study is based on the Systems Theory presented by Joyce and Weil (1980). It holds that the teaching-learning process has inputs and outputs. The best outputs are achieved when the most suitable inputs are used in the best possible way in the teaching-learning process. Immegart and

Pilecki (1973) conceived a system as some form in structure or operation, concept or function, composed of united and integrated parts. Banathy (1968) defined a system as a deliberately designed synthetic organism comprised of interrelated and interacting components which are employed to function in an integrated fashion to attain predetermined purposes. A whole which functions as a whole by virtue of the interdependence of its parts is called a system; and the method which aims at discovering how this is brought about in the widest variety of systems has been called the General Systems Theory (Banathy, 1968). From the General Systems Theory is derived the systems concept (Mukasa – Simiyu, 2001).

The independent variable is the one to which different subjects are exposed to in different degrees or the variable on which the groups of subjects to be compared are different (Kathuri & Pals, 1993). The independent variable is expected to bring about or account for a difference or a change in the dependent variable; the researcher builds the independent variables into the design in order to determine the effects of those factors on the dependent variables (Kathuri & Pals, 1993). According to Kothari (2003), an extraneous variable is an independent variable that is not related to the purpose of the study but may affect the dependent variable. The author asserts that what effect is noticed on the dependant variable as a result of extraneous variables is called an 'experimental error'.

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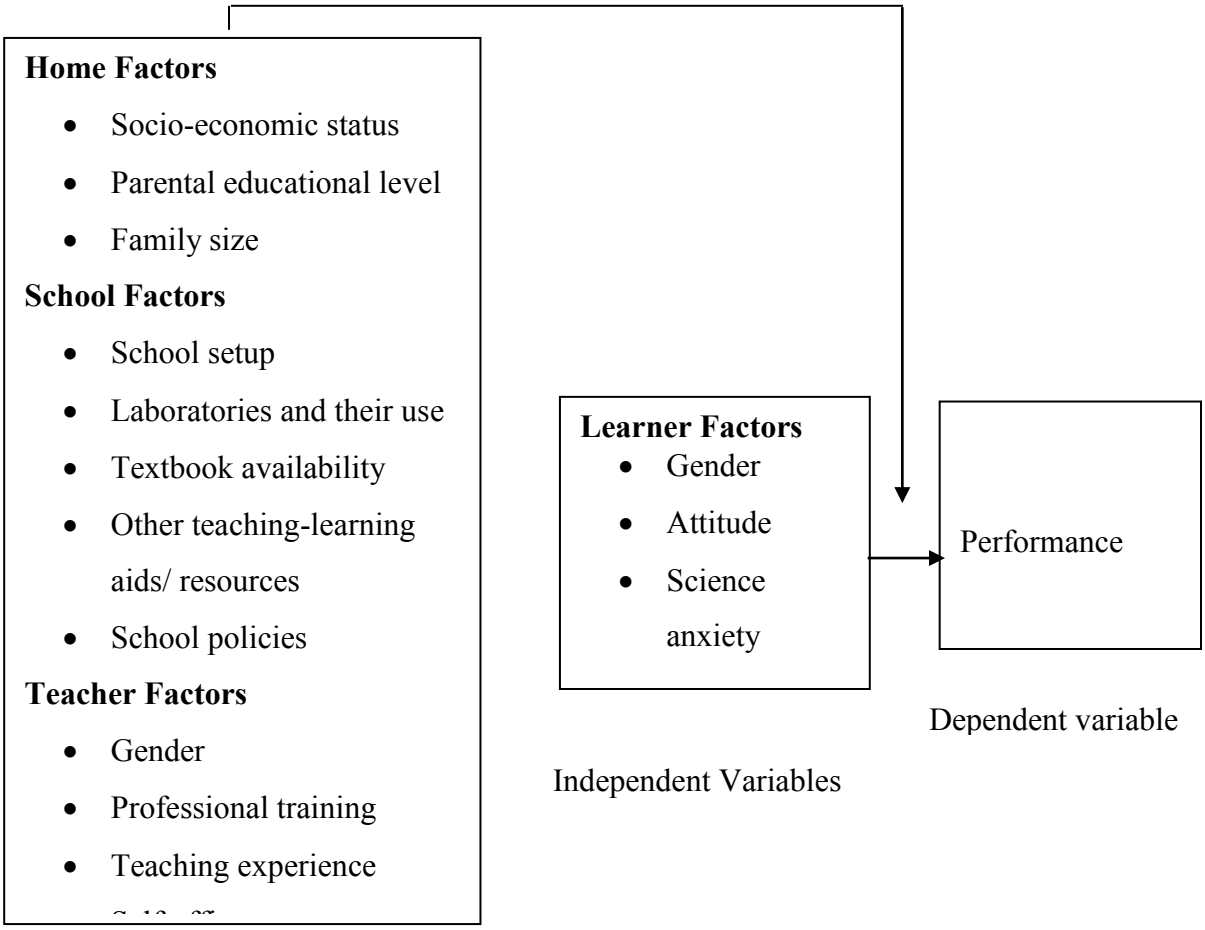

N

Extraneous variables

(Moseti, 2014)

Figure1: The Relationship between Home Factors, School Factors, Teacher Factors, Learner Factors with Performance.

The Systems Theory emphasizes a method of looking at wholes and attempting to establish the relationship among the parts (Mukasa – Simiyu, 2001). The author defines a system as a whole or an entity. That whole or entity has smaller parts within it which are called smaller wholes or entities. These smaller wholes in the larger one are interrelated and they have qualities or attributes which allow them to function as parts of the larger whole. The whole is greater than the sum of the parts (Mukasa – Simiyu, 2001).The author asserts that each one of the parts alone in isolation of the other parts may not reflect the character of the whole of which they each are part.

Methodology

Research Design

The Cross-Sectional descriptive survey design was employed in this study. According to Wiersma (1995),

this research design involves collection of data at one and only one point in time from a random sample representing some target population. This design can be used to measure differences in groups and can be used to measure change when the defined groups reflect change (Wiersma, 1995). According to this author the questions asked in this research design are: What are the characteristics of the variables? What are the relationships and possible effects among the variables? In this design the treatment is included by selection rather than manipulation (Orodho, 2003). The purpose of this design is to find causative relation between events or situations. In this design it may not always be possible to assume the simple causative relation between independent and dependent variables (Orodho, 2003).

The characteristics of the Cross-Sectional descriptive survey design were relevant to this study because, the incidence, relationships and distributions of variables were studied. The variables were not manipulated but studied as they occurred in a natural setting. The research design was typical for this study because the design was working to find out the occurrence, relationships and distributions of gender, attitude and science anxiety of the learners and how these factors influence the performance of the students in sciences.

Population

There were 139 secondary schools in the district as reflected by the District Education Officers' (DEO's) office records in the year 2007. The study targeted these schools for the purpose of the research. From the same records the district had a total of 9,901 form three students in the year 2007, in this population 4871 were boys and 4030 were girls. This was the target population of students in this study. The district was chosen for this study due to the convenience, time allowed and the financial resources available to the researcher. This was also supported by the fact that the researcher knows the area of the district better than other districts.

Sampling Procedures and Sample Size

The study drew the sample from the registered secondary schools as reflected by the District Education officer's (D.E.O's) office records. Table 1 shows the number of secondary schools by category according to the type of school set-up and the number of schools that were selected for study per category.

Table 1: Number of Registered Secondary Schools And Their Categories According To The School Setup.

Type of school setup	**No. of schools**	**No. of schools to be selected**
Single gender boys boarding schools	10	1
Single gender girls boarding schools	18	1
Single gender girls day schools	2	1
Co-educational boarding schools	2	1
Co-educational day schools	77	3
Co-educational boarding and day schools	30	2
Total	139	9

Source: District education office, NYAMIRA, 2007

A representative sample of 9 secondary schools was used. The schools were selected using the Quota sampling technique as advocated by Kathuri and Pals (1993). This type of sampling is the equivalent of stratified sampling, with the added requirement that each stratum is generally represented in the sample in the same proportion as in the entire population (Kathuri & Pals, 1993). The objective of the Quota sampling technique is to include various groups or quotas of the population in the study (Mugenda & Mugenda, 1999). The simple random sampling technique was applied in selecting schools from each category; this ensured that all schools in the district had an equal chance of being selected for the study. The authors argue that in this sampling technique the cases are handpicked because they are informative or posses the required characteristics. A simple random sampling technique as advocated by Borg and Gall (1989) and Van Dalen (1979) was applied to select the student sample. This procedure involves assigning a number or any other identifying symbol and then using the number or symbol to select the sample size (Kathuri & Pals, 1993). For schools with more than one stream, only one stream was selected using the simple random sampling technique. The students in this selected stream were respondents to the student questionnaire (SQ). 360 students from the schools were the sample size used. The 360 student sample size can be justified from the table, according to Kathuri and Pals (1993). From this table when N is 9000, then S is 368. NYAMIRA district had a population of 9901 form three students in the year 2007 and therefore a sample of 360 was appropriate, so that 40 students from each of the 9 schools selected were used. Table 2 shows the sample size can be determined.

Table2: Table for determining needed size of a randomly chosen sample from a given finite population of N

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2013	322
55	48	320	175	2200	327
60	52	340	181	2400	331

65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	241	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20130	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	100000	384

N = population size; S = sample size (Kathuri & Pals, 1993)

The sample proportion will be within plus or minus .05 of the population proportion with a 95 percent level of confidence (Kathuri & Pals, 1993)

Instrumentation

Information was collected using the questionnaire. A Students Questionnaire (SQ) was the main instrument used. However information on students' performance was collected in the different schools by using mark lists that were provided by the class teachers. The questionnaire is easy to administer and more time saving compared to other tools like interview schedules, tests and observations. The questionnaire had closed form items. The (SQ) was designed to seek information from the students concerning their gender, type of school, and anxiety towards learning sciences, the resources

available for the teaching and learning of sciences in their schools, how their gender could impact on their attitude and science anxiety towards the learning of science subjects.

The Strait – Trait Anxiety Inventory (STAI) which was part of the questionnaire was used to collect data from the students as related to science anxiety. This is a standardized test originally developed to study the relationship between anxiety and learning. Westerback (1984) and (Czerniak 1989, 1992) adapted the STAI to measure anxiety and self - efficacy about teaching science. The STAI was used to measure the levels of science anxiety of the students.

Data Collection Procedures

The data were collected by administering questionnaires to students. In administering the questionnaires the respondents were assured that the information they provide shall be treated with utmost confidentiality and would be used for the research purpose only. The researcher gave the questionnaires to the respondents in person. Clarifications were made where necessary. Sufficient time was allowed for them to respond to the items accurately. Data for the study were collected for a period of one month. Before the data collection for this study began, a formal letter was written to the Ministry of Education (MOE). This was requesting for a research permit. This permit was availed formally to the heads (principals) of the schools that had been selected for research. This also enabled the heads of schools to give the researcher permission into their schools and to have access to the students. The researcher spend about two hours in a school

Data Analysis

The data were analyzed by use of descriptive statistics. The data were analyzed using the *Statistical Package for Social Sciences (*SPSS-11.5*)* on computer. The data were provided in reference to the responses given by the students to the Student Questionnaire (SQ). Systematical content analysis technique (Orodho, 2003) was used where the responses were classified according to meaning. In this analysis both designation and attribution of characterizations and descriptors are used (Orodho, 2003). This was necessary to underline assertions that could be characterized in a particular way. Designation was important to determine the frequency with which certain concepts were mentioned. Attribution was important to examine the frequency with which certain characterizations and descriptors were used with emphasis on descriptive phrases and qualifiers. All the completed questionnaires were examined by the researcher. They were coded and appropriately organized for analysis. The information was keyed into the computer for statistical analysis. The coding was done by assigning numbers to represent responses. Thus the numeric coding was used. Table 3 shows a summary of the statistical procedures that were used for data analysis.

Table 3: Summary of Statistical Procedures Used For Data Analysis

	Research Questions	Independent Variable(s)	Dependent Variable(s)	Statistical Procedures
1	What is the influence of g students' gender on performance in sciences?	Gender	Performance	Means, Percentages and Frequencies
2	What is the influence of students' attitude on performance in sciences?	Attitude	Performance	Means, Percentages and Frequencies
3	What is the influence of students' science anxiety on performance in sciences?	Science anxiety	Performance	Means, Percentages and Frequencies

Results

Background information on participants

In order to get background information about the students, the following factors formed the parameters of inquiry; the students' gender and category of the school in terms of boarding/ day school status and the gender status in terms of single or mixed gender. The mixed gender schools are also referred to as co- educational schools.

Gender distribution of the students

Some of the factors that militate for or against students' academic performance tend to give leverage to the male-child at expense of the girl-child (Mondoh, 2001). Against this background, this study was interested in the distribution of the student sample in relation to gender. Table 4 carries information about the distribution of the student sample in terms of their gender.

Table 4: Gender Distribution Of The Students In The Study

Gender	F	%
Male	168	46.7
Female	192	53.3

Information in the Table 4 shows that the students who participated in the study were males (46.4%) and females (53.6%). In this table female students who participated were more than the males. This is because out of the nine (9) schools sampled two (2) schools were girls' only schools. This automatically gave a higher number of female students in the sample. This was aimed at gathering more information from the girl students about the gender differences and biases in relation to the learning of science subjects

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The number of students in terms of gender distribution in selected schools

The educational attainment of girls has been associated with the type of educational institution one attends (UNESCO, 2003). Table 5 shows the distribution of the student sample in the different types of schools selected for the study as related to their gender. The schools were identified by the numbers

Table 5: The Number Of Students In Terms Of Gender Distribution In Selected Schools.

No. of school	Type of school	Gender distribution		
1.	Single gender Boys boarding school	**M** 40	**F** ———	**Total** 40
2.	Single gender Girls boarding school	———	40	40
3.	Single gender Girls day school	———	40	40
4.	Co-educational boarding school	28	12	40
5.	Co- educational Day and boarding school	21	19	40
6.	Co- educational Day and boarding school	21	19	40
7.	Co-educational Day- school	23	17	40
8.	Co-educational Day-school	24	16	40
9.	Co-educational Day-school	11	29	40
Total		168	192	360

Information in Table 5 shows that six (6) co-educational schools were used in the study with different school's set-up or organization. Information in Table 8 shows that in most co-educational schools, girls are usually the minority. This could have an influence on their attitude and science anxiety in the learning of science subjects, especially when the number of male science teachers is more than that of the female science teachers. The science subjects in such a school would appear to be male dominated.

Factors that elicit negative attitude of students towards learning sciences

Attitudes are not innate but are formed as a result of an individuals contact with the object and its environment (Supe, 1992). In relation to the teaching and learning of sciences, attitudes begin to develop on the first encounter between the teacher and the learner. Once formed they can play a key role in determining a student's learning and performance. Table 6 carries information, which according to the students could be some factors that could elicit a negative attitude of the student towards learning the science subjects.

Table 6: Factors That Elicit Negative Attitude Of The Students Towards Learning Sciences.

Factors	**F**	**%**
Quality of teaching methodology frequently used.	10	28.6
Authoritarian and impersonal teacher- student interaction in class.	13	37.1
Large class size that minimize teacher- student interaction in class.	12	34.3
Total	35	100.0

Information from Table 6 indicates that most students (37.1%) observed that authoritarian and impersonal teacher- student interaction in class could be the major factor that contributes to negative attitude of the students towards learning the sciences. Quality of teaching methodology frequently used and large class sizes also contribute significantly in the formation of a negative attitude by the learners towards the teaching of science subjects. Large class sizes minimize teacher-student interaction in class.

Factors that elicit positive attitude of the students towards learning sciences

Attitudes are very important for effective learning; a negative attitude towards learning a subject makes the learner to dislike the subject and may not appreciate the efforts of the teacher in assisting them to achieve higher in the subject while a positive attitude will make the learners to like the subject and put in more effort to compliment the work of the teachers (Twoli, 1996). Table 7 carries information that according to the students are some factors that could elicit a positive attitude of the learner towards learning the science subjects.

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Table 7: Factors That Elicit Positive Attitude Of The Students Towards Learning Sciences

Factors	f	%
Quality of teaching methodology frequently used.	10	28.6
Democratic and personal teacher- student interaction in class	13	37.1
Small or medium sized classes that maximize teacher-student interaction.	12	34.3
Total	35	100.0

Information from Table 7 indicates that democratic and personal teacher-student interrelation in class elicits positive attitude towards learning science. This according to the teachers could be the major factor that contributes to positive attitude. Quality of teaching methodology frequently used and small class sizes also contribute significantly in the development of positive attitude of the learners. Small class sizes according to the teachers maximize teacher- student interaction in class. The quality of teaching methodology frequently used, teacher-student interaction in class and class sizes could have an influence on the attitude of the learners towards science subjects. The quality of classroom life, teachers' attitude and teaching style and class sizes are all important but from Table 6 and Table 7 it is apparent that the type of teacher-student interaction in class seems to be a stronger indicator of educational quality in science classes Figure 2 shows the general average performance of students in the three main science subjects since joining form one in relation to their gender as at the time of the research.

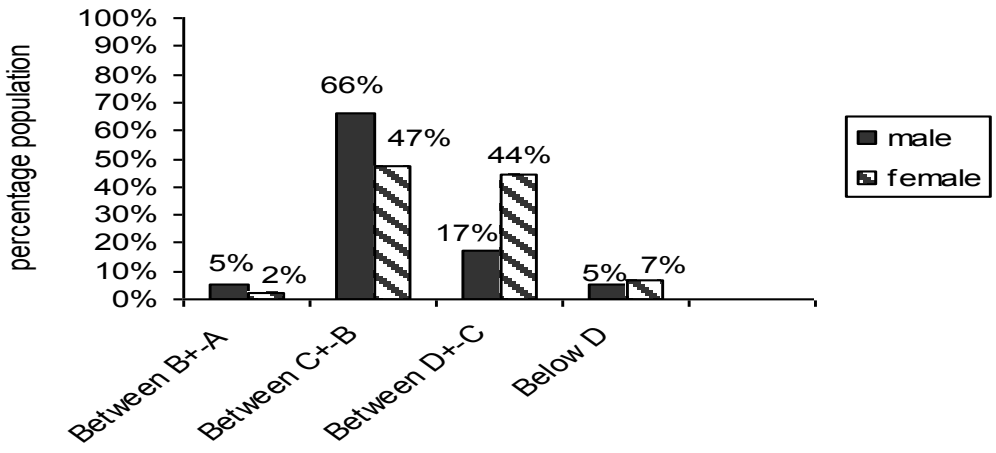

Figure 2: The General Mean Grade Performance In The Three Main Science Subjects.

Information in Figure 2 indicates that male students had an overall better performance than the female students. For the higher grades between B+ and A the male students had (5%) representation while the female students had (2%) representation. Between grade C+ and B, the male students were represented by (66%) while the female students were represented by (47%). The female students on the other hand had a higher representation in lower grades. Thus from the Figure 2 the female students led in the grades between D+ and C by (44%) while the male students had (17%) representation. The lowest category of the grade below D the female students still led by (7%) while the male students had (5%) representation. This implies that science subjects are gender related. Students were asked to state the science subject they liked most. Figure 3 shows the distribution of the student sample in terms of the science subject they liked most as related to their gender.

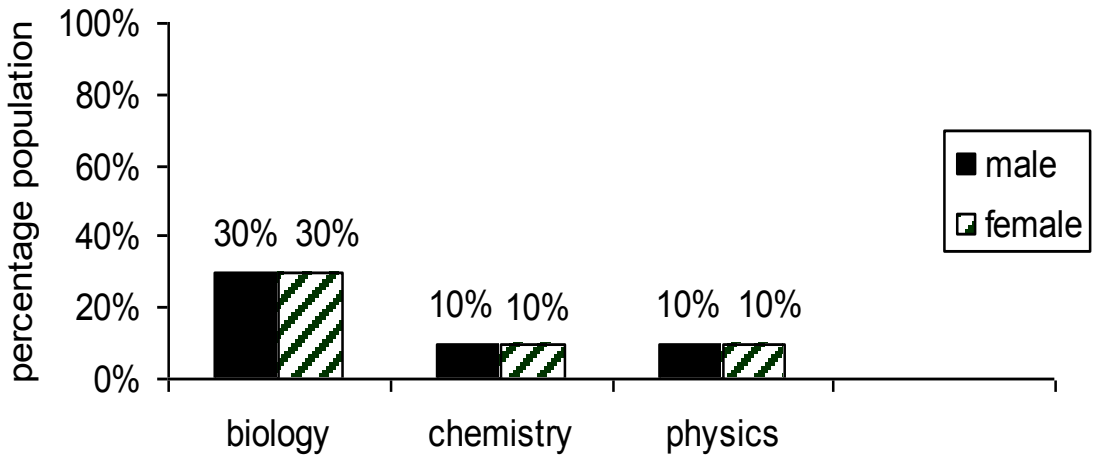

Figure 3: Science Subject Liked Most As Related To The Students' Gender

Information in Figure 3 reveals that a large number of students (60%) liked biology. The subject was equally liked; male students (30%) and female students (30%). Chemistry and physics were less liked. This implies that majority of the students (60%) of both gender had a positive attitude towards biology as compared to the other science subjects. Students were also asked to state the science subject they disliked most. This was aimed at making a comparison between the most liked and the most disliked science subject, because the liking for one subject does not necessarily translate into the dislike for another subject. Figure 4 shows the distribution of the student sample in terms of the science subject disliked most as related to their gender.

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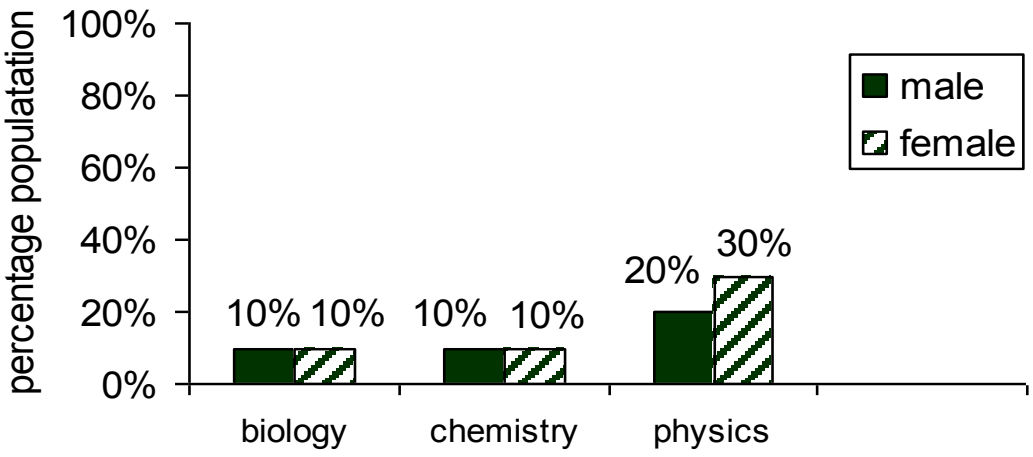

Figure 4: Science Subject Disliked Most As Related To The Students' Gender

Information in Figure 4 indicates that physics is the most disliked science subject by (50%) of the students with male students (20%) and female students (30%). Biology and chemistry are less disliked. Both subjects were equally disliked by male students (10%) and female students (10%). From Figure 4 some students (20%) dislike biology and therefore had a negative attitude towards the subject. Nevertheless from both Figure 3 and Figure 4 the numbers of students who like biology are more than those who disliked the subject.

Students' main source of motivation to study Sciences

Students' performance expectations influence their persistence at tasks, their achievement and their aspirations (Tsuma & Trowsbrige, 1985). The students' source of motivation to study any science subject influences their attitude towards the subject; students can like or dislike the depending on their source of motivation to study the subject. Table 8 shows the distribution of the student sample according to their main source of motivation to study sciences.

Table 8: Students' Main Source Of Motivation To Study Sciences

Main source of motivation	**F**	**%**
Parents	36	10.0
Teachers	108	30.0
Peers	36	10.0
Self-achievement Motivation	180	50.0
Total	360	100.0

Information in Table 8 indicates that most students (50%) had self-achievement motivation as their main driving force to study sciences. Self- achievement motivation is the integrative motivational orientation in learning that is intrinsic. Therefore information in Table 21 implies that most of the students (50%) were intrinsically motivated to study sciences, as opposed to the instrumental motivational orientation that is extrinsic. Table 8 also reveals that the role of teachers in the motivation of learners to study sciences is quite important. One hundred and eight students (30%) indicated that teachers were their main source of motivation to study sciences. This implies that teachers' behavior and teaching practices have significant implications for students' persistence, academic achievement and attainment more than that of the parents or the peers.

Reasons for liking biology as related to the students' gender

Different students whether boys or girls have diverse reasons for liking biology. A student who likes biology as a learning subject in the school curriculum will also have a positive attitude towards the subject. Table 9 shows the distribution of the student sample according to the reasons that made them to like biology. This table shows the distribution in relation to the students' gender.

Table 9: Reasons For Liking Biology As Related To The Students' Gender.

Reason	Gender M		Gender F		
	F	%	F	%	Total
Good teaching foundations given in form one.	16	10.0	38	20.0	54
Biology has higher career prospects.	34	20.0	38	20.0	72
Biology deals with real life and immediate surroundings.	68	40.0	58	30.0	126
Biology has few mathematical calculations.	0.0	0.0	10	5.0	10
Biological concepts are easy to understand.	34	20.0	19	10.0	53
Teachers have very high expectations in terms of students' performance.	8	5.0	10	5.0	18
Democratic and personal teacher-student interaction in the classroom	8	5.0	19	10.0	27
Total	168	100.0	192	100.0	360

Information in Table 9 indicates that most students liked biology because the content of the subject deals with real life and immediate surroundings. This implies that to most students the biological concepts are not abstract. Sixty eight (40%) of the male students and fifty eight (30%) of the female students had this opinion. Thirty-four (20%) of the male students and thirty eight (20%) of the female students liked biology because it had

higher career prospects. Some students (10%) male and (20%) female students reported that they liked biology because of the good teaching foundations they received in form one. Only ten female students (5%) indicated that they liked biology because of the few mathematical calculations involved in the subject. From Table 9 it is revealed that male students and female students could have different reasons for liking biology although some reasons are common for both genders. Table 9 also reveals that high teacher expectations and the democratic and personal teacher – student interaction had more influence on the female students than the male students in causing them to like biology.

Reasons for disliking physics as related to the students' gender

While it is true that the largest proportion of students liked biology, there was a fairly large proportion (50%) of them who disliked the physics. Just like those who liked biology had diverse reasons, even those that disliked physics had their own reasons. Table 10 shows the distribution of the student sample according to the reasons that made them to dislike physics. The table shows the distribution in relation to the students' gender.

Table 10: Reasons For Disliking Physics As Related To The Students' Gender.

	Gender M		Gender F		Total
Reason	**F**	**%**	**F**	**%**	
Poor teaching foundations given in form one	34	20.2	46	23.8	80
Difficult scientific terminology	66	39.3	96	50.0	162
The teacher express very high expectations of the students in terms of performance	19	11.3	18	9.5	37
Authoritarian are in personal teacher-student interaction in the classroom	49	29.2	32	16.7	81

Information in Table 10 reveals that male and female students had diverse reasons for disliking physics. However some reasons stand-out as common for both genders. A large proportion of the students held the view that difficult scientific terminology used in physics was their main reason for disliking the subject, sixty six (39.3%) of the male students and ninety six (50.0%) of the female students felt that difficult scientific terminology was their main reason for disliking physics. Thirty four (20.2%) of the male students and forty six (23.8%) of the female students felt that the poor teaching foundations given in form one contributed to their dislike of physics. Table 10 also reveals that forty nine male students (29.2%) and thirty two female students (16.2%) disliked physics because of the authoritarian teacher -students' interaction in class. This implies that most male students were negatively influenced by the authoritarian teacher- student interaction in the classroom. From both Table 9 and Table 10 it is indicated that very high teacher

expectations work positively for some students but negatively for others as related to both genders. For some students, very high teacher expectations in terms of their performance make them to like the subject. This implies that this kind of students knew that they can measure up to the teachers' expectations. For those students who know that they are unable to measure up to the teachers' expectations, they tend to dislike the subject.

Attitude levels of students towards sciences

Attitude is an important factor in influencing performance (Banu, 1985). Attitudes are not innate but are formed as a result of an individuals contact with the object and its environment (Supe, 1992). Chepcheing (1995) asserts that early socialization which children are taken through tends to make them develop attitudes that lend support to the mistaken notion that mathematics and sciences are not for girls. This then makes the girls to have a negative attitude towards science subjects but concentrate on other subjects. The learners' previous knowledge and experiences, expectations, interests and beliefs have an impact on the way learning takes place (Ndirangu, 2013). The students were asked to respond to an attitude inventory that measured their levels of attitude scores with a total of 25 on the Linkert scale. Table 11 below shows the mean attitude scores, the gender and the numbers of students that responded to the attitude inventory.

Table 11: Mean Attitude Scores Of The Students Of Both Gender

Variable	**Attitude**	
Questions: Strongly disagree – strongly agree (1-2-3-4-5)	**Gender**	
	M (N=162)	F (N=168)
	Mean-score	Mean-score
Sciences are an easy subject to understand	3.5	3.5
Sciences lead to good careers	3.2	3.4
All sciences should be made compulsory	3.1	3.2
I would like to take a science course at a higher level of my education	4.5	3.6
I enjoy learning sciences	4.8	4.9
Total Mean-scores / 25	**19.1**	**18.6**

Information in Table 11 reveals that both male students and female students have high attitude scores above 10/25. This implies that students of both genders have a fairly positive attitude towards the learning of sciences in general. Nevertheless, Table 11 also reveals that male students have a higher attitude score (19.1/25) as compared to the female students (18.6/25). These figures are statistically significant. This implies that male students have a relatively more positive attitude compared to the female students in the learning of sciences.

Causes of anxiety towards learning of Science Subjects related to students' gender

The Social Cognitive Theory suggests that anxiety is a result of feelings of inefficacy (Bandura, 1997). Students of both genders were asked to give the main cause of their anxiety towards the learning of sciences. Different students of both genders had diverse causes of science anxiety. Table 12 shows the distribution of the student sample according to the main cause of anxiety towards the learning of science subjects as related to their gender.

Table 12: Causes Of Anxiety Towards Learning Of Sciences Related To Students' Gender

Main cause	**Gender M**		**Gender F**	
	f	**%**	**F**	**%**
Increasing difficulty and complexity of the subject	17	10.7	35	18.4
Lack of teacher role models of same gender in the subject	16	9.5	50	26.5
Lack of remedial teaching and consultation	34	20.2	16	8.2
The teacher teaches very fast giving no room for mastery of concepts	17	10.1	16	8.2
The teacher always wants right answers in class when questioning	16	9.5	19	10.1
Lack of adequate practical lessons	34	20.2	28	14.3
Long and congested syllabus	34	20,2	28	14.3
Total	168	100.0	192	100.0

Information in Table 12 indicates that students of both genders had diverse reasons that cause them to develop anxiety towards the learning of sciences. Most female students (26.5%) developed anxiety towards the learning of sciences because of lack of teacher role models of the same gender. This serves the fact that most of the science teachers are male. Twenty eight (14.3%) of the female students held a view that lack of adequate practical lessons could contribute towards anxiety, another twenty eight (14.3%) female students believed that a long a congested syllabus was their main cause of anxiety. More female students (10.1%) as compared to the male students (9.5%) developed anxiety towards the subject when the teacher always expected right answers from them when questioning in class. A large percentage of male students (60.6%) developed anxiety because of three main causes namely; lack of remedial teaching and consultation, lack of adequate practical lessons and a long and congested syllabus.

Science anxiety levels of the students

Science anxiety can be an important factor in influencing

performance (Czerniak, 1989). The students were asked to respond to the STAI which measured their levels of science anxiety. The STAI had three scales namely; the anxiety scale, confidence scale and interest scale. Table 13 below carries information showing the mean scores of each gender and the number of students. The total of the mean scores gave the level of science anxiety for both the male students and the female students.

Table 13: Mean Scores Of Levels Of Science Anxiety Of Both Gender Of The Students

Variable	Gender	Mean	N
Anxiety scale			
At ease – anxious	M	3.8	168
1-2-3-4-5-6-7	F	3.6	192
Confidence scale			
Confident – fearful	M	2.9	168
1-2-3-4-5-6-7	F	2.9	192
Interest scale			
Curious – uninterested	M	2.4	168
1-2-3-4-5-6-7	F	3.1	192
Total mean scores	M	**9.1**	
	F	**9.6**	

Information in Table 13 shows that male students have a lower level of science anxiety (9.1) as compared to the female students with a higher level of science anxiety (9.6). These figures are statistically significant. This implies that girls had a relatively higher science anxiety than the boys. But the gap seems to be narrowing down when compared to the findings of Westerback (1984) and Czerniak (1989). The earlier findings indicated a wider gap.

Discussion of Research Findings

This section provides a discussion of the research

finding. The findings are discussed under the following sub headings in order to adequately address each research question.

(i) Influence of students' gender on performance in science subjects.

(ii) Influence of students' attitude on performance in science subjects.

(iii) Influence of students' science anxiety on performance in science subjects.

Girls' education in Africa and elsewhere has been plagued by a pedagogical approach that stresses differences between boys and girls, or men and women, rather than on their similarities. Gender bias refers to the differential treatment of males and females on account of their different sexes based on socio-cultural grounds (Hyde, 1998). Many of the gender differences that are observed between males and females are not usually biological in nature but socio-cultural. Also, it has been found that there is no inherent (biological) reason why boys should be better than girls in learning science, mathematics and technology (Changeiywo, 2001).

Awareness of gender inequality in education is as old as education itself. Studies in different nations have shown that women were not represented in the same proportion as those of the relevant age groups in the population at large (Fulton, 1991). Traditionally, socio-cultural beliefs held it that women should grow up, marry and have babies while boys need to educated so that they can get good jobs. Some research findings based in Kenya indicate that girls' attitudes towards SMT subjects are reinforced by socio-cultural beliefs, modes of teacher-student interaction and negative attitudes of boys towards girls as learners of the same subjects, this contributes to lower female performance in the SMT subjects (Mwangi, 1983; Eshiwani, 1984; Obura, 1991; Makau, 1994). Perhaps the possible explanation for observed differences could be the early socialization which children are taken through or accustomed to. This according to Eshiwani (1983) tend to make the children to develop interior attitudes that lend support to the mistaken notion that mathematics and sciences are not for girls, because often the society at large view these subjects as unimportant for home-making roles which girls are expected to play in future. This then makes the girls to concentrate on other subjects like the languages and humanities.

In a classroom setting, academic performance in science subjects varies from one student to another. This occurrence is usually observed despite the fact that the students are subjected under the same syllabus, curriculum, teachers and school facilities among other factors. This suggests that variability in academic performance in biology from one individual student to another can be attributed to other factors such as gender, attitude and science anxiety among other factors.

Influence of Students' Gender on Performance in Sciences

It was found in this study that boys generally perform better than girls in sciences. This finding is similar to that of the KNEC Report (2003). This report indicated that in sciences boys performed better than girls when the percentage of students who achieved a B grade and above was analyzed. The boys had 0.87 percent and the girls had 0.63 percent. In other science subjects, performance in chemistry was 7.1 percent and 3.9 percent for boys and girls respectively. In physics the

boys had 0.25 percent while the girls had 0.01 percent.

With regard to the overall performance at the KCSE, generally girls are lower achievers than boys (Eshiwani, 1985). The author notes that at the primary school level, the worst performance for girls was in mathematics and science. That finding was further supported by Maritim (1985) who asserted that boys did better than girls in all the subjects. Kaggia (1985) supported this conclusion. More recent data on performance shows that girls still perform relatively poorly in biology, physics chemistry and mathematics indicating that girls seem to perform better than the boys in the language subjects in the KCSE examination (Kombo, 2004). It is however important to note that given a generally conducive environment, girls can perform as well as, if not better than boys (Eshiwani 1983).Various studies indicate that girls in single- gender schools tend to perform better in national examinations than those in co-educational schools particularly in SMT subjects (FAWE, 2004). In co-educational schools, the learning environment is usually hostile towards the girls (Odaga & Henveld, 1995). The authors observe that in this kind of schools, hostility towards the girls is depicted by harassment, teasing and ridicule from boys if one is intelligent and when one is not very intelligent. UNESCO (2003) reported that girls in single – gender schools had more positive experiences with science and were better able to study and follow science careers. The report indicated that in co-educational schools, the girls were passive in science and mathematics classes. During the practical and laboratory sessions, girls took records while boys carried out experiments and therefore, the educational attainment of girls is associated with the type of educational institution one attends (UNESCO, 2003).

In this study it was found that girls are the minority in co- educational schools. This finding is similar to that of UNESCO (2003). The report indicated that in most co-educational schools girls are usually the minority and hence there is a strong gender bias in subject choices available for girls. According to UNESCO (2003) there are three main reasons why male students always dominated co-educational schools. First, that there is cultural proclivity for seeing talk by women as too much talk. Second, social pressure requires that females could be good listeners and their verbal participation is seen as less important. Three, women are discouraged from talking by the teachers. Verbal and non-verbal messages such as delayed feedback, speech interruptions and withholding of active listening responses like nods or just by gazing at them.

This study found that teachers' perceptions and comparisons about the performance of their students in biology rated the boys higher than the girls. This finding is similar to that of Nanda (1991).The teachers' influences at school have also been found to be a hindrance to girls' option for science and mathematics (Bolt, 1986). Studies have shown that teachers tend to carry the societal expectations of girls into the school and therefore treat boys different from girls (Whyte, 1984). Some teachers are said to actually discourage girls by uttering statements like "mathematics and science are not meant for girls" (Wamahiu, Opondo & Nyagah , 1992). The negative societal perceptions regarding female involvement in science and technological fields are also transmitted within the educational system through books. According to a study carried out in Kenya by Obura (1991), it was found that

textbooks in schools are a major socializing factor in the lives of children. First and foremost the text books present models of people. They present behavior and thought patterns which they imply are good to copy. The school as a social institution is authoritative and the textbooks used there carry authoritative messages on role models. The school and the textbooks preach social conformity in behavior and ideology (Obura 1991). The author points out that the children are captive audiences who are exposed to a common national curriculum. Therefore the children are exposed to a common culture, ideologies and a common set of values and norms. However in Kenya complaints have been raised on some of the textbooks that carry messages of negative connotations about women especially books in literature of English and 'Fasihi' in Kiswahili (Obura, 1991). Some science textbooks have outer covers of male students and male teaches perfoming experiments (Moseti, 2014). These messages develop into images that can affect the girls self concept that can influence their achievements in sciences.

As (Obura, 1991) points out those textbooks reinforce the alienation of females from scientific and technical activities. Such perceptions are indeed a reality in the girls setting. Tsuma and Trowsbridge (1986) found that by age 12, girls had already developed negative attitudes towards science subjects. These negative attitudes are rooted in societal perceptions of women's role in society and are transmitted to girls through the educational system (Abagi, 1997). A girl is likely to feel different from the proposed male (norm) and therefore deficient with regard to it (Obura, 1991). The author notes that if successful in class a girl may begin to experience gender identity threat especially in a class dominated by boys.

From this study it can be concluded that boys generally perform better than girls in sciences and therefore gender is an important factor that influences academic achievements in science subjects.

Influence of Students' Attitude on Performance in Sciences

It was found that students of both gender had a fairly positive attitude towards science subjects. The students indicated that they developed interest in the subjects because of anticipated career awareness. This finding is similar to that of Seli (2006). This means that the students' interest in the subjects was intrinsically driven by their career prospects. It was established that boys have a relatively more positive attitude than the girls. This finding is similar to those of Banu (1985), Kwon (1984) and those of Horton and Hutchnison (1997). Lucas and Dooley (1982) asserted that women report less positive attitude towards science than do men. Whyte (1986) established that certain teaching styles and methods tend to favor boys. The findings in this study indicated that most teachers of science still use the traditional lecture method. The fact that boys had a more positive attitude towards sciences as compared to the girls agrees with the findings of Whyte (1986). The author asserted that boys show greater adaptability to traditional approaches of teaching which require memorizing abstract and unambiguous facts which have to be acquired quickly, boys are more willing to sacrifice deep understanding of correct answers achieved at speed.

A student learning science will understand the value of concepts learnt or taught when he / she can see their utility in practical life (Shumba 1993). The findings in

this study indicated that the largest proportion of students of both genders liked biology because the subject deals with real life and the immediate surroundings. This implies that students find the concepts in biology applicable in their practical life. These findings lend credence to the assertion of Shumba (1993) that students value concepts whose application and utility can be seen in real life. Shumba (1993) observed that attitudes are very important for effective learning.

Students of both genders who reported their disliked for physics cited the authoritarian and impersonal teacher – student interaction in class as the main causes for negative attitude towards the subject. Anderson (1970) established that the relationship between the teacher and the pupils in the Kenyan classroom was authoritarian and impersonal. In addition he observed that the underlying basis for interaction is that the students have come to school to be taught, the teachers' role is therefore to tutor them rather than to provoke them to learn. Students are not treated as thinking human beings that had their own views and experiences, which could be used to lead them, see the relevance of the new information they are learning (Anderdson, 1970).

Westerback and Long (1990) found that to motivate students to learn, feedback on their progress should take many forms; verbal recognition and written analysis of their work. Seli (2006) observed that teachers as role models were responsible for formation of positive attitudes towards a curriculum. Teachers' behavior and teaching practices have significant implications for female students' persistence, academic achievement and attainment (FAWE, 2004). Most teachers have differential expectations for students' responses in activities like teacher-led class discussions, where boys are spoken to more frequently and asked higher order questions (Seli, 2006). This definitely discourages the girls and leads to a relatively lower attitude. These differential expectations about the students in reference to their gender are a reflection of the broader societal biases about the role of women in society and the academic capacity of girls.

Classroom observations in Kenya indicated that most teachers pay more attention to boys than girls or completely ignore the girls, at times boys received more attention in the distribution of text books and other learning materials and at times teachers reinforce the belief that girls lack spatial and analytical thinking (UNESCO, 2006). This is internalized and conclusively accepted thus justifying the self – fulfilling prophecy that there are certain subjects that are not for girls (Nyongesa 2010).

Influence of Students' Science Anxiety on performance in Sciences

The findings of this study indicate that girls have a higher level of science anxiety than the boys. This findings are similar to those of (Czermiak, 1992), who found that females as early as the third grade, exhibit more anxiety than their male counterparts. This science anxiety may contribute to the students particularly females low enrolments in science classes (Westerback, 1984).This study found out that some girls developed science anxiety because of lack of teacher role models of the same gender. Thus there was a general shortage of female teachers because male teachers dominated in most schools. Even though role modeling through female teachers has proved quite effective in some

single – gender secondary schools in Kenya where girl schools have tended to outperform boy schools in science and mathematics very few co-educational schools can boast of such advantages (Twoli, 1986).

Science anxiety is a product of low self-efficacy (Yager & Penick, 1985). Bandura (1997) developed the Social Cognitive Theory from a programmed research on social development that had spanned several decades. The major construct emerging from this research is the construct of self-efficacy, a cognitive processing mechanism that guides human action. Self-Efficacy, according to Bandura (1997) is one's perceived performance capabilities in a given situation or activity. This perceived performance capability affects behavior and attitude. According to Bandura (1997) people gather information about their self-efficacy in various ways. He observes that through various experiences; people observe others succeeding or failing in given situations and develop expectations for their own performance accordingly. Social influences such as positive reinforcement and verbal persuasion contribute to perceived capabilities and the strongest factor affecting self-efficacy is actual performance attainment, that is, success (Bandura, 1997). According to Bandura (1997) self-efficacy affects thoughts, actions and emotions; he suggests that thoughts include how we think we can perform in a particular situation or activity. One has to believe that one's behavior can bring about a desired outcome if one is to execute the behavior required to achieve that outcome (Bandura, 1997). Self-efficacy judgments influence performance and aspirations, including career goals and persistence at a task is enhanced when one believes in his/her own ability to continue the task despite the obstacles (Horton & Hurtchinson, 1997). For example, if one perceives oneself as incapable of comprehending science or mathematics and fails to persist in order to learn science and mathematics, it is unlikely one will pursue a career in medicine, technology, or other science/math-related areas (Horton & Hurtchinson, 1997).When one dwells on personal deficiencies, perceived or real, and imagines potential difficulties, anxiety is produced, and one is likely to form an image that leads to stress and anxiety and the physiological indicators of anxiety (Bandura, 1997). Students' performance expectations influence their persistence at tasks, their achievement, and their aspirations (Bandura, 1986). Students' self-efficacy seems to affect their ability to learn science, students are likely to become anxious about science after repeated bad experiences, such as; poor science instruction, few role models, especially for females; personal failure in science, and negative attitudes of adults and peers (Westerback, 1984). The author observes that, once students have had repeated bad experiences with science, their perceptions of their capabilities (self-efficacy) are affected negatively. This leads to inferior images of self ability and results in anxiety and negative attitudes towards science.

Conclusions

The conclusions made were based on the findings of the study as presented. A basic question relates to the proper role of the science teachers in enhancing learning. What criteria should guide us in determining what the teacher can try to do, much less what he or she can do? Where

must the teacher begin? Can the science teacher effect sufficient change of attitude and learning behavior? There is no sufficient understanding of the effects that various teaching practices have on raising or lowering student attitude and science anxiety gender-wise (Nyongesa,2010). From this; it is inevitable to conclude that the students, the teachers, the school and the parents have a crucial role to play towards successful achievement in science. It can also be concluded that if we measure the cost in terms of unfulfilled human desires, underdeveloped capabilities and unexplored potential for improving the quality of science education, any amount of money needed to do the job will be well worthy the expenditure (Nyongesa,2010). This is in consideration of the fact that, we are living in an age in human history of high technology and industrialization where science education plays a key role. For better students' achievement in sciences, the teacher should not be isolated and the parents' role should not be taken for granted. On issues of gender and their influence on performance in sciences; it is inevitable to conclude that the parents and the community must forge a clear working relationship with the teachers and with the school, it must be accepted that the parents which in essence are part of the community are key components in the professional work of teachers who are also products of the community (Moseti, 2014). The gender perspectives that are already engrained in the community about women can be changed with a clear working relationship between parents, the community, teachers and the school. This is because the traditional role of the school is conceived to be that of transmitting the culture and a conservator of the existing social system, and all the consequences which ensue, on the other hand, the learning problems with which the school must deal with do not exist in isolation (Moseti, 2014). The author posits that the school where the teacher is found should act as a locus of activity in coordinating the solutions to these problems. Therefore teachers of science must consider the emotional, social and intellectual constructs if we are to examine the total educational goal of schools in a free society. The school should stimulate the kind of participation which gives positive support to the learning of sciences, such as supply of teaching-learning aids. These instructional materials should be free of gender biases and stereotypes. This can effectively take care of the attitudes and science anxiety of the students in the learning of sciences in regard to gender. Finally, it can be concluded that gender, attitude and science anxiety and their influence on performance in sciences are inseparable and must be addressed collectively. There relationship can be illustrated in the model shown below. Figure 5 shows the inter-relationship between gender, attitude, science anxiety and performance in biology as envisaged by this study.

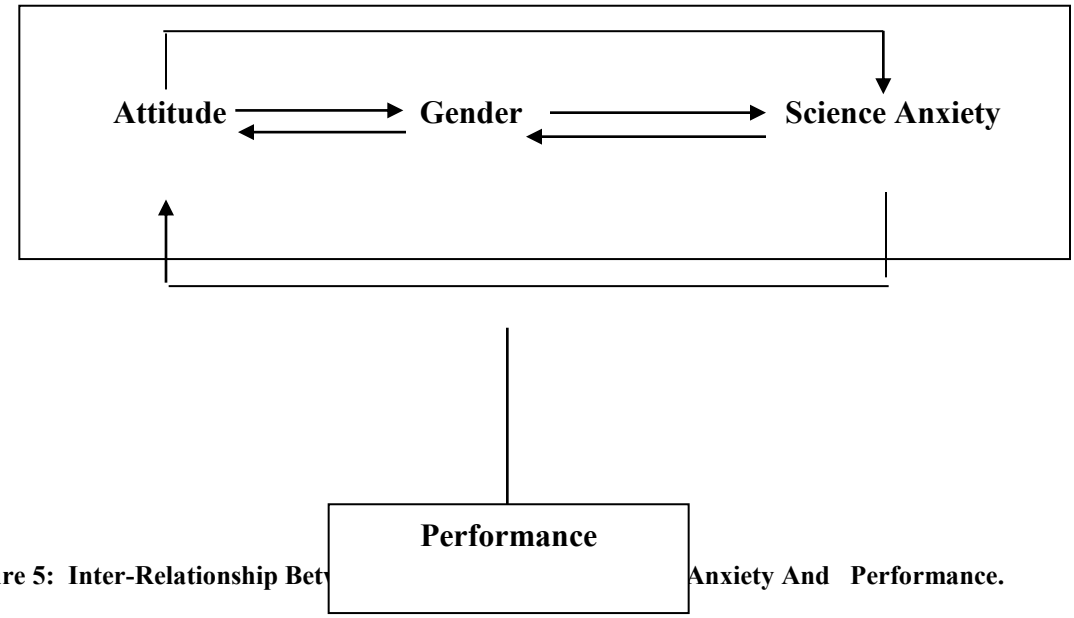

Figure 5: Inter-Relationship Bet Anxiety And Performance.

(Moseti, 2014)

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