DISPARITIES IN CHEMISTRY AND BIOLOGY ACHIEVEMENT IN SECONDARY SCHOOLS: IMPLICATIONS FOR VISION 2030

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Abstract

The differential representation of men and women in the scientific community has been foretold by achievement patterns evident in the elementary and secondary levels. There is a substantial body of research that documents gender differences in science and it shows that males outperform females on science achievement tests. This study focuses on achievement in chemistry and biology because they are treated as compulsory subjects in most schools and thus taken by all the registered candidates while the third science, physics, remains optional in many schools. The two sciences are also regarded as instrumental in driving Kenya's vision 2030 initiative which aims at making the country a newly industrializing middle income country providing high quality life for all its citizens. The realization of this vision calls for the harnessing of the science capacity of both men and women in the country for economic prosperity. This study adopted a descriptive survey design. This paper presents the findings of the study on disparities in achievement in chemistry and biology in Kenya with a focus in Western Province. This study was conducted in 40 secondary schools in Western Province. Out of the selected 40 schools, responses were obtained from 32 schools giving a response rate of 80%. The data collection instrument was the questionnaire. Data on achievement in chemistry and biology was obtained from the respective Heads of Departments. The study revealed that there are disparities in achievement among the different school categories and as well as gender. Boys' schools realised higher mean scores in chemistry and biology during the five years compared to girls' and co-educational schools. However, although the boys' schools maintained the lead, performance in chemistry can only be described as average for both the boys' and girls' schools. Co-educational schools underperformed. These findings indicate that such achievement is working against the realization of Vision 2030.

Key words: Achievement, industrializing, disparity, quality, capacity and Vision 2030

Introduction

The differential representation of men and women in the scientific community has been foretold by achievement patterns evident in the elementary and secondary levels (Cakiroglu, 1999). Boys perform better than girls in achievement tests in the typically masculine areas of maths and science. There is a substantial body of research that documents gender differences in science and it shows that males outperform females on science achievement tests (Chipman, Brush and Wilson, 1985; Fennema, 1984; Linn and Hyde, 1989; Oakes, 1990; Lee and Burkam, 1996). Observations of such differences have been reinforced by the view that boys are "naturally" better equipped to excel in science (Jacobs and Eccles, 1985). Such stereotypes that men are naturally more talented and interested in science are thought to influence the science, technology and engineering aspirations and achievements of boys and girls, men and women (Frome and Eccles, 1998; Furnham, Revees and Budhani, 2002; Klefer and Sekaqueptew, 2007).

Some data on low female achievement has also come from the cross-cultural survey of science achievement carried out by International Evaluation of Educational Achievement (IEA). The results of the three IEA science studies namely; First International Science Study (FISS), the Second International Science Study (SISS) and Third International Mathematics and Science Study (TIMMS) reveal that sex differences have been found in every subject area in the written science achievement tests. The sex difference favoured males. The 1999 and 2003 findings reveal that boys outperformed girls and had a larger variance. The SISS conducted between 1983 and 1984 in 24 countries showed that differences in science achievement favoured boys in Biology, Chemistry and Physics at all levels. Results of the 1995-1996 TIMMS show that boys had a significantly higher mean achievement than girls in both the seventh and eighth grades internationally in many countries.

A later study on international trends in science achievement in 46 countries shows that in the US, among fourth graders in 2007, males continued to outperform females in science with minimal differences but among the eighth graders, males scored significantly higher overall than females in science (Cakiroglu, 1999; Mullis, Martin and Foy, 2008).The 1986 National Assessment of Educational Progress (NAEP) carried out in the United States earlier had reported that boys had outperformed girls in sciences achievement and the gender gap increased as students progressed in school. A later assessment by NAEP in 2005 revealed that males outperformed females in science achievement in grades 4, 8 and 12. Females at all levels made relatively little gains in their average science scores since 1996. In most cases by grade 11, the areas of largest male advantage were physics, chemistry, earth science and space science (Kahle and Meece, 1994). In the final year of secondary school, males had a significantly higher achievement in scientific literacy than females in all participating countries (EU, 2009).

The scenario is not any different in Africa. In Uganda for example, the trend in academic excellence has shown that boys perform better than girls in chemistry. However, a study was carried out to determine if there were any gender differences in the performance of chemistry skills among senior six girls and boys in selected secondary schools in Kampala. A total of 50 students participated (25 boys and 25 girls). Although there were no differences in the students' ability to manipulate apparatus and report results, girls had poor self confidence in their ability as most of them believed that boys were better (Ssempala, 2005). In Kenya, similar results are evident. IPAR (2003) study on the performance of students in KCSE revealed that in science subjects the percentage gap in Physics in the four districts under study was 5% in Kiambu, 8% in Bungoma, 8.7% in Kisumu. The same trend was observed in Chemistry and Biology.

In terms of equity, women have not attained educational equity in many African countries and they are systematically under-represented in scientific and technical disciplines (Adams and Kruppenbach, 1986 as cited in Frazier, 1999). In these countries, the number of women enrolled in science based training and those involved in science based professions are among the lowest in the world (Frazier, 1999). Elsewhere, research does show some decline in gender differences in science achievement in some countries but with low female representation in science related fields (Jacobs, 2005). Males continue to surpass females in the number of undergraduate degrees awarded in science and engineering fields especially in computer science, physical science and engineering (National Science Foundation, 2005). The share of females enrolled in science was below 20% in Botswana, Gambia, Guinea and Nigeria. The proportion in engineering was below 10% in Ghana and Swaziland (UNESCO, 2008).Gender differences in achievement have been attributed to a variety of biological and environmental factors in what usually comes down to nature versus nurture debate (Dee, 2005).

Some studies show that any biological differences interact with environmental factors that appear soon after birth (Naiser et al, 1996). Researchers who emphasize environmental (nurture) factors often blame societal expectations based on commonly held myths about gender. Johnson and Murphy (1984) found that societal expectations for men and women result in different expectations in the early socialization of girls and boys that are reinforced by appropriate role models from real life in the media and text books. Both male and female teachers have a negative attitude towards girls' abilities to perform well in mathematics and science. Teachers cite girls' fear of the subjects, lower determination and lower intelligence when compared to boys. Bali (1997) found that the majority of teachers believed that boys would join the university to train as doctors, engineers and architects while girls were only capable of being tailors, teachers and secretaries. Generally, teachers usually interact differently with boys and girls and some evidence suggests that students benefit academically from having teachers who are of the same gender as themselves (Dee, 2007).

In addition, schools, teachers and the curriculum encourage girls to adopt passive and dependent behaviour while boys adopt aggressive and independent behaviour. The differential treatment of boys and girls also affects performance. Girls ask fewer procedural questions; receive significantly less praise, fewer direct questions and little bevavioural warning from their teachers (Jones, 1991; Jones and Wheatley, 1990). Teachers hold different expectations for their students based on genders and subsequently treat them differently based on these expectations (Becker, 1981). Thus classroom interaction patterns result in greater opportunities for boys than girls to learn science and may reflect performance achievement expectations for boys (Kahle and Meece, 1994; Jones and Wheatley, 1990). An international research carried out to determine whether implicit gender science stereotypes could account for sex differences in science achievement indicated that there was a positive relationship.

A national indicator of implicit gender- science stereotyping was related to a nation's sex differences in science achievement and by extension, to other markers of diverse scientific leadership (Nosek, et al, 2006). Research thus attributes low achievement of girls in science to lower parental expectations and encouragement. Girls are socialized into characteristics of dependence, nurturance and passivity. They therefore develop a set of attitudes and beliefs that do not promote high levels of achievement and participation in science. Studies have found that females have more negative attitude towards math and science (Wasanga, 1997). According to Wasanga (1997), the majority of girls found science subjects difficult and they perceived science subjects to be more useful to boys. Aghenta, (1989) found that perceived difficulties of science occupations was a significant factor preventing girls from entering Science, Technology and Mathematics (STM) fields. The attitude that one holds towards science appears to be a powerful predictor of achievement in the respective field. A poor attitude to STM was a barrier to access of STM related fields but conversely, a good or positive attitude was one of the several factors that facilitated performance in STM. Achievement differences are also influenced by single sex versus mixed sex schools.

In Kenya, secondary school ends with the Kenya Certificate of Secondary Education (KCSE) examination. Students are expected to take two science subjects drawn from the cluster of Chemistry, Biology and Physics. However, most schools treat Biology and Chemistry as compulsory science subjects which must be taken by all the candidates. It is very important for students to be proficient in these subjects because they play an important role in career choices and professional development. Dismal performance in the sciences limits girls' opportunities in competitive professional courses that are science oriented. Furthermore, Kenya's vision 2030 initiative aims at making the country a newly industrializing middle income country providing high quality life for all its citizens. The realization of this vision calls for the harnessing of the science ability of both men and women in the country so that they can contribute to nation building. However, this vision is not about to be realized for as long as girls continue to underachieve in subjects that determine their placement in science oriented fields which are expected to spur industrialization. It is against this background that this study seeks to establish the gender disparities in performance in chemistry and biology; and the factors contributing to these patterns.

Objectives of the Study

1. To establish disparities in performance in Chemistry in KCSE between 2005-2009
2. To establish disparities in performance in Biology in KCSE between 2005-2009
3. To investigate the factors influencing differential achievement in Chemistry
4. To investigate the factors influencing differential achievement in Biology.

Research Methodology

Research Design

The study adopted a descriptive survey design. Descriptive research is concerned with conditions or relationships that exist, practices that prevail, processes that are going on, attitudes that are held or trends that are developing (Best, 1970). The design facilitated the collection of information on the current disparities on achievement in chemistry and biology. It yielded information which is analysed using descriptive and inferential statistics. The design also permitted an assessment of the factors influencing achievement in the two science subjects.

Participants and settings

The sampling frame was secondary schools in Western Province. The schools were stratified into three categories of Boys' boarding, girls' boarding and co-educational (mixed) day schools. The study used Heads of Science Departments (HoSDs) in schools. There were 40 HoSDs chosen as respondents representing the administrative authority in their respective departments in their schools. Responses were received from 32 schools. The study covered schools which were ranked in the 2009 KCSE provincial merit ranking list. A multi-stage sampling method was used at two levels. The first level of sampling was stratification according to school categories based on their performance in the 2009 KCSE examination results. This was to ensure that homogenous sub-sets that share characteristics are in one group. It also ensured equal representation of the population in the sample. The second level was random sampling involving each stratum.

Instrument

The main data collection instrument in this study was the questionnaire. The questionnaire was developed for the respondent to fill in information on their gender, the school type, mean scores in chemistry and biology during each of the five year period and factors contributing to the indicated performance trends.

For consistency, the questionnaire had questions which were closed-ended. The choice of this instrument of data collection is suitable because it is free from bias and hence reliable. It is also easy to administer to a large group and allows adequate time for well thought out answers**.**

Data Analysis

Data collected from the field was checked to ensure that they were accurate, consistent with other facts gathered and well arranged to facilitate coding and computer keying. Both descriptive and inferential statistics were used in the analysis with the aid of the SPSS package. Since this study was comparing performance among different school categories, one way Analysis of Variance (ANOVA) was used to test the difference between groups (boys' boarding, girls' boarding and co-educational (mixed) day schools during the five year period). To establish any significant statistical differences in gender performance, the t-test was used. Information on factors affecting performance in chemistry and biology is tabulated.

Results

This section reports the findings of the study on disparities in achievement in chemistry and biology in Kenya with a focus on Western Province. This study was conducted in 40 secondary schools in Western Province. Out of the selected 40 schools, responses were obtained from 32 schools translating to 80% response rate. Of the 32 secondary schools, 16 are provincial while 16 are district schools. Further classification grouped the schools into boys' boarding (8), girls' boarding (8) and mixed day schools/co-educational (16). Data on achievement was obtained from the respective HoDs. Disparities are examined at the level of the different categories of schools and gender. The findings are presented in the order of the objectives of the study.

1. Disparities in the achievement in chemistry between 2005-2009

The study sought to establish the disparities in performance in chemistry by the different categories of schools during the five years. The results are tabulated in Table 1.1.

Table 1.1: Performance in chemistry (2005-2009)

School category	Year					
	2005	2006	2007	2008	2009	Average
Boys Boarding	6.061	6.448	6.392	6.475	6.036	6.282
Girls Boarding	5.330	4.980	4.827	5.804	4.958	5.180
Co educational	3.190	3.103	2.971	3.434	3.182	3.176

Source: Field data

The results in Table 1.1 does indicate differences in performance by the school categories with boys' schools having an upper hand for the last five years as shown by the mean scores of the school categories. Boys schools had the highest average mean of 6.282 (C), followed by girls' schools' 5.180 (C^-). The co-educational schools recorded the least performance of 3.176 (D). A critical look at the table also reveals that generally the performance of the school categories over the five years is unstable. In addition, the results reveal dismal performance in chemistry. The grade C performance is relatively low based on the fact that most of the science oriented careers at degree level require a minimum grade of C^+ in chemistry. This may jeopardise the opportunity of these students to enrol in such competitive careers.

The study sought to establish whether there exists a difference in the chemistry achievement among the school types in the five years. To do this a one way ANOVA way used. The results are tabulated in Table 1.2.

Table 1.2 One Way ANOVA table on achievement in chemistry among different schools in five years

	Sum of squares	df	Mean squares	F	sig
Between groups	57.079	2	28.539	16.889	.0001
Within groups	49.004	29	1.690		
Total	106.083	31			

The results in Table 1.2 indicate that there is a difference in the chemistry achievement among the different categories of schools. The F observed value of 16.889 is greater than the F critical of 3.33 (p value=0.0001, at 0.05 level of significance).

Further analysis using a t-test was done to determine if there is any statistical difference in the mean achievement of boys' and girls' boarding schools. The result does indicate that there are disparities in the performance of the different categories of schools and among boys and girls. The t-observed value of 12.788; p value=0.0001 at 0.05 level of significance; is greater than t- critical of 2.131. In both cases, the statistical tests reinforce the findings that there are disparities in the performance of the different categories of schools and among boys and girls.

2. Disparities in the performance of Biology

The study also sought to establish the disparities in performance in biology among the different categories of schools during the five years. The results are summarized in Table 2.1.

Table 2.1: Performance in Biology (2005-2009)

School category	Year					
	2005	2006	2007	2008	2009	Average
Boys Boarding	6.985	7.431	8.477	7.944	7.737	7.715
Girls Boarding	6.218	6.079	5.741	6.527	6.631	6.240
Co educational	3.686	3.316	3.274	4.022	4.037	3.667

Source: Field data

The results in Table 2.1 show a similar trend as it were in chemistry. The results do indicate boys' schools excelling in biology just as it were in chemistry. Boys schools recorded the highest average mean of 7.715 (B^-) followed by the girls schools' 6.240 (C). The mixed day schools posted the least performance with an average mean of 3.667 (D^+). However, the average mean for biology for the school categories is higher compared to chemistry. This may be attributed to the perceived perception of the mathematical aspect in chemistry by many students to be hard. The results also pose a great challenge for students enrolled in girls' and mixed schools to enrol in science oriented careers. The trend in performance also shows that boys improved between 2006 and 2007 then realised a drop in subsequent years while girls and co-educational schools dropped between 2006 and 2007 and then registered an improvement in the subsequent years. This trend in performance in the school categories does indicate the need for strategies to improve the performance in biology for the school types while at the same time maintaining a steady performance. However, there is need for concerted efforts to drastically improve the dismal performance in mixed schools. The study found it necessary to establish whether there is a significant difference in the biology achievement among the means of the different school categories. To do this the study employed the use of a one way ANOVA. The results are tabulated in Table 2.2.

Table 2.2: One way ANOVA table on achievement in biology among different schools categories in five years

	Sum of squares	df	Mean squares	F	sig.
Between groups	96.362	2	48.181	34.353	.0001
Within groups	40.673	29	1.403		
Total	137.035	31			

The result in Table 2.2 does indicate that there is a significant difference in the biology achievement among the means of the different categories of schools. The F observed value of 34.353 is greater than the F critical of 3.33 (p value=0.0001, at 0.05 level of significance). Further analysis using a t-test was done to determine if there is any statistical difference in the mean achievement of boys' and girls' boarding schools. The t observed value of 17.144; p value=0.0001 at 0.05 level of significance; is greater than t- critical of 2.131. The result does indicate that there are disparities in the performance of the different categories of schools and among boys and girls. In both cases, the statistical tests reinforce the findings that there are disparities in the performance of the different categories of schools and among boys and girls.

3. Factors influencing differential achievement in chemistry

Since this study sought to establish factors influencing achievement in chemistry, respondents were asked to indicate the extent to which a number of given factors (lack of or availably of facilities, learners' attitude, learners practice and learners' interest) influenced performance in their schools. The results are summarized according to each of the four factors in Tables 3.1, 3.2, 3.3, and 3.4

3.1. Effect of facilities on performance in chemistry The respondents were asked to indicate how lack of or the availability of sufficient facilities influenced performance in chemistry in their schools. The results are summarized in Table 3.1

Table 3.1: Effect of facilities on performance in chemistry

	Lack of facilities and poor performance			Availability of sufficient facilities and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	2	2	1	1	2	-	8
Girls	1	4	1	2	0	-	8
Co-educ	5	5	-	4	1	1	16
Total	8	11	2	7	3	1	32

Legend: L. Ext-Large Extend, S.Ex- Small Extend, No eff-No effect

Table 3.1 reveals that provision of facilities is one factor that is likely to account for poor or good performance in chemistry. The result among the school categories indicates a larger percentage (90.66%) of the respondents attribute performance in chemistry to lack of or availability of facilities. 8 (25%) of the respondents attribute poor performance to lack of facilities while 7 (21.88%) attribute good performance to availability of sufficient facilities. Apparently, 3 (9.34%) of the respondents feel that facilities have no effect on a schools' poor or good performance. Similar results across the school categories also show performance in chemistry highly depends on lack of or availability of facilities. 87.5% (7), 87.5% (7) and 93.75% (16) of the respondents from boys', girls' and mixed schools respectively did agree that performance in chemistry depends on lack of or availability of facilities. However, the majority of respondents from mixed schools attributed low achievement in chemistry to lack of facilities. The results thus indicate the need to enhance the availability of facilities in the teaching of chemistry in the school categories.

3.2. Effect of learners' attitude on performance in chemistry

Responses were also sought on the effect of learners' attitude on the performance of chemistry in the school categories. Thus the respondents were asked to indicate the extent to which attitude affects performance in chemistry. The findings are presented in Table 3.2.

Table 3.2: Effect of learners' attitude on performance in chemistry

	Negative attitude and poor performance			**Positive attitude and good performance**			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	3	2	-	3	-	-	8
Girls	5	1	-	2	-	-	8
Co-educ	7	3	-	3	3	-	16
Total	15	6	0	8	3	0	32

The results in Table 3.2 clearly show that a larger proportion of respondents (71.86%) felt that learners attitude does affect performance in chemistry. The results indicate that 15 (46.88%) among the school categories felt that negative attitude by learners to a larger extent lead to poor performance while 8 (25%) felt that a positive attitude contributes to good. The same scenario is depicted across the school categories with 6 (75%), 8 (87.50%) and 10 (62.50%) of respondents from boys', girls' and co-educational schools respectively attributing students attitude to good or bad performance. None among or across the school categories disputed the fact that learners attitude has no effect on chemistry achievement. 3 (9.38%) 7 (21.88%) 5 (15.6%) of the responses from boys', girls' and co-educational schools respectively attribute low achievement in chemistry is to negative attitude by students. Although the problem of the negative attitude towards the subject is more pronounced in co-educational schools and girls schools, it is nevertheless universal since only 3 respondents from boys' schools attribute good performance to a positive attitude. The result does indicate the urgent need to address the issue of negative attitude among the students to reverse the trend in chemistry achievement.

3.3. Effect of Learners' practice on performance in chemistry

The study was interested to establish whether learners' practice has an effect on the performance of chemistry in the school categories.

Respondents were thus asked to indicate the extent to which learners practice affects performance in chemistry. The findings are presented in Table 3.3.

Table 3.3: Effect of learners' practice on performance in chemistry

	Lack of practice and poor performance			**Sufficient practice and good performance**			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	4	1	-	3	-	-	8
Girls	4	2	-	2	-	-	8
Co-educ	1	6	3	4	2	-	16
Total	9	9	3	9	2	-	32

Similarly, on the effect of learners' practice and performance, responses indicate that in all the categories of schools, there is lack of practice by learners. 9 (28.13%) of the respondents attribute poor performance to lack of practice and another 9 (28.13%) felt the improvement in chemistry in their schools was due to sufficient practice by the students. The results reinforce the fact that practice makes perfect hence the need for teachers to engage students in more practice in chemistry lessons.

3.4. The effect of learners' interest on performance in chemistry

Scholars have argued that learners' interest in the learning process has an effect on education attainment. The study sought the opinion of the respondents on the same. Thus respondents were asked to assess the students' interest in the achievement in chemistry. The findings are presented in Table 3.4.

Table 3.4: The effect of learners' interest on performance in chemistry

	Lack of interest and poor performance			Sustained interest and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	2	3	-	3	-	-	8
Girls	4	2	-	2	-	-	8
Coeducational	6	4	-	4	2	-	16
Total	12	9	-	9	2	-	32

Interest in a subject is known to influence the students' perception of the difficulty of the subject and subsequently, this affects achievement. It was found that interest influenced performance as indicated by 12 (37.5%) respondents of who felt that poor performance was to a large extent caused by students' lack of interest in the subject while 9 (28.12%) of the respondents still attributed poor performance to a small extent to students' lack of interest in the subject. Another 9 (28.12%) felt sustained interest contributed to good performance in their schools.

4. Factors influencing differential achievement in biology

This study also sought to establish factors influencing achievement in biology. To do so respondents were asked to indicate the extent to which a number of given factors (lack of or availably of facilities, learners' attitude, learners practice and learners' interest) influenced performance in biology in their schools. The results are reported in Tables 4.1, 4.2, 4.3, and 4.4 according to each of the four identified factors

4.1. Effect of facilities on performance in biology

To begin with respondents were asked to indicated how lack of or the availability of sufficient facilities influenced performance in biology in their schools. The findings are indicated in Table 4.1

Table 4.1: Effect of facilities on performance in biology

	Lack of facilities and poor performance			Availability of sufficient facilities and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	2	-	1	2	3	-	8
Girls	4	-	1	3	-	-	8
Co-educ	4	3	-	6	2	1	16
Total	10	3	2	11	5	1	32

It can be discerned from Table 4.1 that provision or availability of facilities is one factor that is likely to account for performance in biology. Among the school categories 10 (31.25%) of the respondents attribute poor performance to lack of facilities while almost an equal number 11 (34.34%) attribute good performance to availability of sufficient facilities. This is a strong indication that performance in biology highly depends on facilities.

4.2. Effect of learners' attitude on performance in biology

The respondents also indicated the extent to which attitude affects performance in biology. The findings are presented in Table 4.2.

Table 4.2: Effect of learners' attitude on performance

	Negative attitude and poor performance			Positive attitude and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	3	-	-	2	3	-	8
Girls	5	-	-	2	1	-	8
Co-educ	7	-	-	6	3	-	16
Total	15	0	0	10	7	0	32

The findings does show that a large proportion of the respondents 25 (78.13%) felt that performance in biology depends on learners attitude. 15 (46.88%) of the respondents attributed to a larger extend poor performance in biology to negative attitude while 10 (31.25%) felt that a positive attitude contributed to good performance. The same results are shared across the schools categories where 5 (62.5%) 7 (87.5%) and 13 (81.25%) attributing performance in biology to students attitude. The results thus show that learner's attitude highly affects performance in biology.

4.3. Effect of learners' practice on performance in biology

The respondents were also required to indicate the extent to which learners practice affects performance in biology. The findings are summarized in Table 4.3.

Table 4.3: Effect of learners' practice on performance in biology

	Lack of practice and poor performance			Sufficient practice and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	3	-	-	3	1	1	8
Girls	4	1	-	2	1	-	8
Co-educ	4	2	1	6	3	-	16
Total	11	3	1	11	5	1	32

Similarly, on the effect of learners' practice and performance in biology more than sixty percent (68.75) strongly felt that performance in the subject depends on students' practice. An equal number 11 (34.38%) of the respondents cited frequent and infrequent practice as a factor contributing to poor and bad performance in biology. The results reveal the need for the students to be highly encouraged to take up frequent practice in biology in order to improve the results in the subject in the school categories.

4.4. Effect of learners' interest on performance in biology

Lastly, the study sought to establish whether learners' interest had an effect on performance in biology. Respondents thus were required to indicate the extent to which learners' interest affects performance in the subject in the school categories. The results are tabulated in Table 4.4

Table 4.4: Effect of learners' interest on performance in biology

	Lack of interest and poor performance			Sustained interest and good performance			
Sch Type	L.Ext	S.Ex	No eff	L.Ext	S.Ext	No eff	Total
Boys	1	1	1	4	1	-	8
Girls	3	1	1	-	3	-	8
Co-educ	3	3	1	6	3	-	16
Total	7	5	3	10	7	-	32

The results in Table 4.4 do indicate that interest in the subject also influenced performance as indicated by more than half (53.3%) of the respondents.

However, a small proportion of the respondents (9.34%) felt that lack of interest had no effect o performance.

Discussion

This study revealed there that there are differences in achievement in chemistry and biology among the different categories of schools as well as gender. Generally boys performed better than girls in the two science subjects. In chemistry, the boys had an average mean score of 6.282 while girls had 5.180 revealing a disparity index of 1.1. In biology, boys posted a good performance by averaging at 7.715 while girls only managed to realize 6.240 leading to a disparity index of 1.5. These findings therefore agree with those of Chipman, Brush and Wilson, 1985; Fennema, 1984; Linn and Hyde, 1989; Oakes, 1990; Lee and Burkam, 1996 which showed that males outperform females on science achievement tests. The findings also conform to those of the Second International Science Study (SISS) and Third International Mathematics and Science Study (TIMMS) which revealed that sex differences were found in every subject area in the written science achievement tests and the sex difference favoured males. The variance particularly in biology concurs with the 1999 and 2003 findings which revealed that boys outperformed girls and had a larger variance. The chemistry results are also in harmony with those of a study carried out in Uganda which showed that generally the trend of academic excellence indicated that boys perform better than girls in Chemistry.

The findings of this study show that, with constant underachievement of girls in the science subjects the women are bound to be constantly under-represented in the science fields. This observation from the study agrees with and reinforces the studies which show that women have not attained educational equity in many African countries and they are systematically under-represented in scientific and technical disciplines (Adams and Kruppenbach, 1986 as cited in Frazier, 1999). In these countries, the number of women enrolled in science based training and those involved in science based professions are among the lowest in the world (Frazier, 1999). Therefore, for as long as the trend continues, males continue to surpass females in the number of undergraduate degrees awarded in science as pointed out by the National Science Foundation (2005). Other studies have attributed gender differences in achievement to a variety of biological and environmental factors in what usually comes down to nature versus nurture debate (Dee, 2005). Some studies show that any biological differences interact with environmental factors that appear soon after birth (Naiser et al, 1996). This study however differs from such studies because it did not explore biological and environmental factors influencing performance. It rather examined school based factors within the control of the schools and students. It therefore found that, both male and female students have a negative attitude towards sciences. The attitude problem was more profound in girls' schools' than boys' schools. In girls' schools, teachers cited low self esteem among the students as enhancing the negative attitude and thus affecting performance.

The findings are similar to those of other studies (Wasanga, 1997; Aghenta, 1989) who found that females have more negative attitude towards math and science. Wasanga (1997) found that the majority of girls found science subjects difficult and they perceived science subjects to be more useful to boys. Similarly, Aghenta, (1989) found that perceived difficulties of science occupations was a significant factor preventing girls from entering Science, Technology and Mathematics (STM) fields. The attitude that one holds towards science appears to be a powerful predictor of achievement in the respective field. A poor attitude to STM was a barrier to access of STM related fields but conversely, a good or positive attitude was one of the several factors that facilitated performance in STM. While other studies indicate that girls are socialized into characteristics of dependence, nurturance and passivity and therefore develop a set of attitudes and beliefs that do not promote high levels of achievement and participation in science, this study found that other factors affecting differential achievement in science were availability of facilities, practice by students and interest in the subject. Good performance was linked to availability of sufficient science facilities, frequent practice by students and sustained interest.

Implications for vision 2030

Kenya's vision 2030 initiative aims at making the country a newly industrializing middle income country providing high quality life for all its citizens. In tandem with this overall vision, the vision for the education sector for 2030 is "to have globally competitive quality education, training and research for sustainable development." It has further been emphasized that to achieve this vision, a number of strategic areas, namely, access, quality, equity, science, technology and innovation have been identified for support based on their impacts on the economic, social and political pillars. Science subjects are expected to play an important role in the achievement of Vision 2030 because they can steer industrialization and innovation and thus accelerate economic growth that will in turn improve the quality of lives.

The findings of this study reveal that performance in science subjects remains just average in schools that are deemed to be top performing. The boys' schools maintained a lead in the sciences but the results show that this performance is anything but average especially in chemistry in which the mean is 6.282 (C). The girls are at 5.180(C-) while co educational schools are at 3.176 (D). The implication is that the majority of students are under-performing making access to science oriented courses which can spur industrialization difficult. In biology, the performance among boys' fair among boys' and girls' schools because they are at 7.715(B-), and 6.240 (C) respectively. However, it is still quite low for co educational schools which are at 3.667 (D+). Implementing Vision 2030 will require more knowledge based skills. This calls for more training in science and technological related courses. If secondary school graduates are not realizing the required grades in order to enroll in such courses, the vision remains just a mirage. There must therefore be concerted effort among all stakeholders to address the problem of deplorable performance in science subjects.

Policy strategies for science and technology in education point to the establishing and equipping of science laboratories in all secondary schools to encourage schools to give prominence to science subjects. This study reveals that such a policy has been more theoretical than practical as a number of schools identified lack of sufficient facilities as a factor contributing to poor performance. To put vision 2030 on course, the issues of provision of science facilities in schools ought to be revisited particularly in recently established schools, most of which are co-educational, rely on Subsidized Secondary Education Funds and meet the educational needs of students from low socio-economic status. Such students need the quality life articulated in vision 2030 which can be brought about through industrialization and innovation.

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