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**RESEARCH ARTICLE**

# AN ASSESSMENT OF THE DIFFERENCES IN MATHEMATICS AND CHEMISTRY PERFORMANCE BETWEEN BOYS AND GIRLS IN SECONDARY SCHOOLS IN BOMET DISTRICT, KENYA

***Dr. Daniel K. Korir and Beatrice C. Laigong**
Department of Educational Psychology, Moi University, P.O. Box 3900 – 30100, Eldoret, Kenya.

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## *Abstract*

The study sought to determine whether or not there is a difference in the performance in Mathematics and Chemistry subjects between boys and girls in secondary schools in Kenya. The purpose of the study was to investigate the influence of gender role stereotypes on academic performance among secondary school students in Bomet District, Kenya. Purposive sampling was used to select the schools that were involved in the study and stratified random sampling plan was used to select the participants of the study. A sample of 208 students was randomly selected from the form four classes. A five point Likert scale questionnaire with 20 items was used to obtain measures of students' attitudes. Students' performance in mathematics and Chemistry were obtained from school records. Descriptive statistics such as means, standard deviation and standard error were used to compare academic performance of students with different attitude towards gender role stereotypes. The inferential statistics used included t-test, Pearson correlation co-efficient and ANOVA. The study found that there was a disparity in performance in Chemistry and Mathematics between boys and girls. The implication is that a significant relationship exists between the student's gender and his/her performance in mathematics and chemistry in mixed secondary schools. Thus, teachers of Mathematics and Chemistry in co-educational schools should be cautious about gender disparity. They should be analyzing performance in the subjects according to students' gender in order to monitor this disparity and to foster healthy competition between boys and girls in these two subjects. Thus, teachers of guidance and counselling should come up with programmes of confidence building that will enhance girls' confidence in the two subjects. This can be done by involving female role models such as university lecturers, students pursuing science based courses and female engineers in motivational conferences. The findings are beneficial to teachers, students, parents and other stakeholders in education as they examine the barriers of gender equity with respect to performance in mathematics and chemistry and to enable girls to have more access to science based courses in institutions of higher learning.



## Introduction

### Gender Disparity in Performance in Mathematics and Science

A report by the Kenya Ministry of Education (1995) shows that women are under-represented in science, mathematics and technology at the university. In the University, women are represented by 42.7 per cent in medicine, 9.9 per cent in science, 3.9 per cent in architecture, and by 1.3 per cent and in engineering. The report also

indicates a generally low enrolment of women at the university. This outcome is attributed to girls' lower performance at the secondary school level. Since university admission requires good passes in mathematics and a language, low performance in mathematics could be the limiting factor for girls to enroll in the science based courses.

Gender disparity in mathematics and science has been a major source of concern in most parts of the country. Eisenberg, Fabes and Martin (1996) point out that boys' better performance at math has long been a source of concern. Studies indicates that in Kenya, the 'O' and 'A' level systems of education show that girls' performance in mathematics has been relatively lower than that of the boys. Maritim (1985) and Kaggia (1985) report that boys do better than girls at the 'O' level examinations in all subjects. Chege and Sifuna (2006) maintain that the trend has not changed with the 8-4-4 system of education. Girls continue to trail behind the boys in basic mathematics and sciences. Eshiwani (1983) notes that the worst performed subjects for girls at the primary school level are mathematics and science. This concurs with the findings of Tsuma and Trowbridge (1986) who have discovered that by age 12, girls have already developed a negative attitude towards science. A study by Chepchieng and Kibos (2004) of secondary schools in Baringo District sought to find out the influence of socio-economic status and gender on students academic performance. Socio-economic status and gender were the independent variables whereas performance in mathematics, English and Kiswahili were the dependent variables. The study had a sample of 216 respondents selected from various co-educational schools of the District. Using both descriptive and inferential statistics, a significant mean difference was found to exist only in mathematics between boys and girls. There was no significant difference in the other two subjects. These findings seem to support the view by Beal (1994) that when girls get to high school, they begin to lose considerable confidence in mathematical ability while boys begin to be confident.

Another finding by Chege and Sifuna (2006) also reveals that girls' performance in mathematics was relatively low compared to that of the boys between 2000 and 2003. In 2000, the performance of girls in Mathematics and Chemistry was lower than that of the boys by 5.3 per cent and 4.1 per cent respectively. In 2001, boys performed better than girls by 5.4 per cent in Mathematics and girls did better in Chemistry by 6 per cent. In 2002, male performance was better by 6.1 per cent and 4.5 per cent in Mathematics and Chemistry respectively. In 2003, boys' performance was also better than that of the girls by 6 per cent and 5.3 per cent in Mathematics and Chemistry respectively. Overall girls' performance have been lower than the boys' in Mathematics and Chemistry except in the year 2001 when girls did better than the boys in chemistry. Further, findings in and out of Kenya indicate that on average boys still take the lead in mathematics and sciences. However, on some instances the performance between boys and girls does not differ. In a US survey by Burkham, Lee and Smedon (1997), found that boys in the eight and tenth grades scored higher than girls on science test especially among average and high ability students. In another US national study of science achievement, boys did better than girls in the fourth and eighth grades but there were no differences in the $12^{th}$ grade (National Assessment of Educational Progress, 2001) an indication that there is a possibility of girls doing equally well like boys in sciences at higher levels of education.

A survey among tertiary institutions within Eldoret Municipality found that women constitute less than 20 per cent of students studying science and technical based courses. An example is that in mechanical and automotive engineering where male enrolment was nearly 100 per cent while female enrolment tended toward zero percent. This finding was mainly attributed to girls' poor performance in mathematics and sciences at previous levels (Kadenyi & Kamuyu, 2005). Mwingi (2005) also insists that the rise in female enrolment in secondary school does not correspond with the enrolment in tertiary institutions and in particular university education. There is about 30 per cent female enrolment in public universities with a significantly small number taking science and technology courses. Even though most findings indicate that males outperform females in mathematics and sciences, Hyde and Plant (as cited in Santrock, 2004) caution that such findings refer to averages. It should be noted that not all males outperform females. Males do well in math related to measurement, science and sport while female do better in math related to traditional female tasks such as cooking and sewing.

A survey in Mauritius, found that the percentage of girls taking mathematics was less than that of the boys. The purpose of the survey was to find out the number of girls taking sciences at higher secondary school level. It was found that 36.9 per cent of boys were taking sciences compared to 20.6 per cent of the girls. The survey also found out that girls' schools tended to have fewer laboratories and technical rooms than boys' schools (Gunghana, 1997). This may have contributed to girls' lower performance in science. Findings within and out of Kenya indicate that the performance of boys and girls in mathematics and science vary. Boys tend to outperform the girls in mathematics

and sciences. The fact that the rise in girls' enrolment at the secondary level in Kenya, does not translate to enrolment of girls particularly to science based courses at tertiary institutions.

**Sex Typing at School as a Factor to Performance**

Gender stereotyping is known to exist in schools. There are several ways in which the school reinforces sex typing. Sprinthall, Sprinthall and Oja (1994) point out that school often act to transmit the traditional values of the larger community in general. Gender role stereotypes are not only reinforced at home but also at school where it acts as a reflection of the society's view of what is considered gender appropriate. Feldman (1996) proposes that school hallways present a very different world for males and females. Mondoh (2004) in agreement notes that various school and out of school factors have been found to combine to lower the academic performance and career aspirations of girls even when they remain in school.

Performance of girls in single-sex schools is better than that of girls in co-educational schools since single sex situations give girls extra opportunity to make more academic achievement (Meighan, 1986). An observation by Eshiwani (1983) indicates that several girls' schools appear among the top 10 to 50 in Kenya national examinations implying that if girls are given an environment conducive to learning, they can perform as well as boys if not better. Herz *et al*. (1991) point out that fewer girls than boys gain admission to government schools in Kenya. According to a World Bank Report (1989), girls' schools in Africa often lack the same offering in mathematics and sciences as boys' schools.

**Statement of the Problem**

There are a host of factors that affect academic performance at the secondary school level. Performance by gender at the secondary school level differ in that girls perform better than boys in language subjects and relatively poor in mathematics and key science subjects. Girls in single sex schools perform equally and even better than boys whereas those in mixed secondary schools perform poorer. The disparity of performance by gender has been the trend in Kenya for a long time.

This study therefore compared the performance of girls and boys in Mathematics and Chemistry among Form Four students in mixed secondary schools. In Kenyan education system, emphasis is laid on mathematics and sciences because these subjects are considered important in this modern age of science and technology. Mathematics is a prerequisite in all science related courses whereas chemistry is a basic requirement for agricultural and medical courses at tertiary institutions. In the Kenyan secondary school curriculum, Mathematics is compulsory and any two science subjects. Biology and Physics cannot be pursued without Chemistry; thus making the subject significant in the school curriculum. However, performance of girls in these subjects is low yet they contribute significantly to the overall mean grade. The study therefore sought to find out whether the same holds for students in Bomet District, in regard to performance in Mathematics and Chemistry.

**Limitations of the Study**

The results of the study may not reflect what happens in other parts of the country, thus the findings are only considered applicable to the area of study. This therefore limits the generalization of the study to other districts within Kenya. The sample size of the study was drawn only from Form Four classes in mixed secondary schools; hence the results can only be generalized to mixed secondary schools within Bomet District. Further the study did not examine what happens in primary and single sex secondary schools or even at higher institutions of learning. Again, the sampling method may not given a true representative sample since the ratio of boys to girls varied from one school to another and the scores in Mathematics and Chemistry were not obtained from standardized test; a situation that may not be a true reflection of what students may obtain in KCSE.

## Materials and methods

This study was carried out in Bomet District of the Rift Valley Province, Kenya. The District lies on a latitude of $O^o$ 29' and $1^o$ 03' south of the equator and between a longitude of $35^o$ 05' and $O^o$ 35'East. The neighbouring districts include Nakuru to the east, Kericho to the north east, Nyamira to the west and Narok to the south. The research study adopted a causal-comparative (ex-post facto) research design. This design allows the use of both descriptive and inferential statistics. There are 52 secondary schools in Bomet District out of which 38 are mixed secondary

schools and 14 are single sex. The study involved Form Four students in the mixed secondary schools. The schools that were selected were those that had a large student population of Form Four classes so as to obtain a representative sample. The estimated number of secondary school students in the years 1997 to 2001 had a ratio of 103 to 100 for males and females respectively. The secondary school going age population ranges from 13 to 21 years. The target population was all the secondary school going age students within Bomet District. The study population consisted of all the Form Four students enrolled in mixed secondary schools in Bomet District.

The study used eight mixed secondary schools within Bomet District. The particpants were sampled from form four classes as they would have sat for the three previous consecutive end of term examinations in Mathematics and Chemistry. The Form Four are also in a better position to respond to the questionnaires. From each school, 26 students were selected for the study consisting of 13 boys and 13 girls which translates to a total of 208 participants. The sample size was expected to bear the characteristics of the entire population. Small pieces of paper corresponding to the number of students required (boys and girls) were marked Y while the rest were marked N. The pieces of paper equivalent to the number of boys and girls available were placed in a container and students were allowed to pick a piece of paper each. Only those students who picked papers indicated Y were included in the

The main instrument used in collecting data was a questionnaire consisting of a five-point Likert scale. Subjects were supposed to indicate whether they strongly agree (SA), agree (A), undecided (U) disagree (D), or strongly disagree (SD). (SA) was given a score of 5 points, (A) a score of 4 points, (U) a score of 3 points, (D) a score of 2 points, and (SD) a score of 1 point. Possible highest score was 100 points and the least possible score was 20 points. The attitude scores were categorized into two, the positive and negative attitude. Attitude scores ranging from 60-100 points were treated as positive attitude while scores from 20-59 points were treated as negative attitude. The academic performance was obtained from the school records with the assistance of the class teachers or any other relevant teacher in the absence of a class teacher. Mathematics and chemistry scores for three previous consecutive terms were obtained for the students who were involved in the study. The mean average scores for each gender were worked out. An average score above 40 per cent was treated as high performance and a score below 40 per cent was treated as low performance.

Data was analyzed using the Statistical Package for Social Sciences (SPSS) computer program. Descriptive statistics such as means and standard deviations were used to compare performance in Mathematics and Chemistry as well as the attitudes towards gender role stereotypes between boys and girls. The t-test was used to determine the relationships between students' academic performance and students' attitude towards gender role stereotypes.

## Results and discussion

The study sought to compare the performance of boys and girls in Mathematics and Chemistry. To achieve this objective, research hypotheses were generated as follows: $HO_1$: there is no significant difference between boys and girls performance in Mathematics and the second hypotheses was stated as $HO_{2:}$ there is no significant difference in the performance of boys and girls in chemistry. To test these two hypotheses, performance of respondents in Mathematics and Chemistry were obtained for three previous consecutive terms. Mean scores for each subject and for each participant were obtained. Further analyses was done using SPSS computer program. The results were as shown in Tables 1 and 2.

**Table 1: Mathematics and Chemistry Mean Score for Male and Female Students**

| Score | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Mathematics | Male | 104 | 28.1275 | 19.2136 | 1.9024 |
| | Female | 104 | 22.3208 | 14.8533 | 1.4427 |
| Chemistry | Male | 104 | 36.1667 | 16.1491 | 1.5990 |
| | Female | 104 | 29.1415 | 14.8705 | 1.4444 |

Table1 shows that there is a variation in the performance of boys and girls in Mathematics and Chemistry. It indicates that the means for boys are higher than that of girls in both Chemistry and Mathematics.

**Table 2: t-test of Significance in Mathematics and Chemistry**

| Scores | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Mathematics | 2.444 | 206 | .015 | 5.8067 | 1.1223 | 10.4911 |
| | 2.432 | 190 | .016 | 5.8067 | 1.0971 | 10.5163 |
| Chemistry | 3.265 | 206 | .001 | 7.0252 | 2.7837 | 11.2666 |
| | 3.260 | 203 | .001 | 7.0252 | 2.7766 | 11.2737 |

The t-test further revealed that there was significant difference in performance of Mathematics and Chemistry, $t(206) = 2.44$, $p = 0.015 < 0.05$ and $t(206) = 2.44$, $p = 0.001 < 0.05$ respectively. This implied that there was a significant difference in performance between male and female students in Mathematics and Chemistry. The null hypothesis, that there is no significant difference in performance of boys and girls in mathematics and chemistry was therefore rejected. The findings of the study on the gender disparity in Mathematics and Chemistry are in agreement with The KCSE results of 2000 and 2001. The results also indicated that girls' performance in Mathematics was lower than that of the boys. These findings are also in agreement with earlier studies of Chepchieng and Kibos (2004), Chege and Sifuna (2006), who found that the performance of boys were better than that of girls in mathematics and sciences. These findings also agree with the views of Kadenyi and Kamuyu (2001) and Ministry of Education (1995) which attribute the results to the fact that there are fewer women taking science based courses at tertiary institutions in Kenya to a lower performance by girls in mathematics and sciences at the secondary school level.

However, these findings were not expected in some ways. This is because the study was conducted in co-educational schools where girls share the same learning experiences with boys. They share the same text books and are taught by the same teachers. This contradicts earlier suggestions that if girls and boys are given same chances they can perform equally. In mixed Secondary Schools boys and girls receive relatively the same learning experiences. Quinn (2001) observes that in high school, boys and girls perform equally in Mathematics classes. The fact that boys' performance in mathematics and science is better than that of the girls does not mean that girls cannot do better than boys, as Hyde and Plant (as cited in Santrock, 2004) observe that the differences only refer to averages and not individual performance. The findings of the study focus on means and not on the individual input of the students. For instance, studies by Boit (1986) found that girls perform as well as boys in Mathematics. Rothstein (1990) concurs that when girls are encouraged to take up science and technical subjects, there is no measured difference in performance between males and females.

The fact that there has been a disparity in performance between boys and girls may mean that adequate attention has not been made towards it. To the extent that boys and girls learning in the same class have different mean scores urgent measures need to be undertaken. The fact that girls in single sex schools and some in mixed schools can have high scores in Mathematics means that the gap can be closed.

## Conclusion and recommendations

The study findings reveal that there is a significant difference in the performance of Mathematics and Chemistry between boys and girls. This means that a significant relationship exists between the student's gender and performance in Mathematics and Chemistry in mixed secondary school.

From the study findings, it is recommended that teachers of Mathematics and Chemistry in co-educational schools should be cautious about gender disparity. They should be analyzing performance in the subjects according to gender in order to monitor the gap. This would also help foster healthy competitions between boys and girls in the two subjects. Teachers of guidance and counselling should also come up with programs of confidence building that will help the girls to gain confidence in the subjects. This can be done by involving female role models like successful female scientist, female university lecturers, students pursuing science based courses and female engineers. This would give encouragement to the girls and boost their self esteem with respect to the two subjects.

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