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DISPARITIES IN MATHEMATICS ACHIEVEMENT AMONG SECONDARY SCHOOLS: THE CASE OF KENYA

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Abstract

In Kenya, one the subjects tested by the Kenya National Examinations Council (KNEC) in the Kenya Certificate of Secondary Education (KCSE) is mathematics which is a compulsory subject for all candidates. Although competence in mathematics is paramount due to constant change in the global economy and workplace, achievement in the subject remains dismal. It is very important for students to be proficient in this subject because it plays an important role in career choices and professional development. Underachievement in mathematics limits ones opportunities in competitive professional courses at all tertiary levels. This study sought to establish disparities in the achievement of mathematics in KCSE during 2005-2009 among boys' and girls' boarding schools and mixed day schools. Descriptive research design was adopted and data was collected from the Heads of Mathematics Departments in 32 secondary schools in Western Province. Descriptive and inferential statistics were used in the analysis. The findings reveal that there are wide disparities in the performance among the different categories of schools as well as gender. Boys' boarding schools have a lead in achievement in mathematics. Factors mentioned as contributing to poor performance in mathematics include lack of sufficient text books, negative attitude by students and teachers, lack of frequent practice by students and the influence of previous poor performance. It is hoped that these findings will assist teachers and secondary school administrators address factors contributing to poor performance in mathematics. It is recommended that school administrators should provide sufficient learning materials. In schools with low achievement in mathematics, there should be a concerted effort by entire staff to change the attitude of students towards the subject and incentives given for any minimal improvement realized.

Key words: achievement, disparities, intrinsic, professional development and proficient.

Introduction

International student assessments provide a particularly good opportunity to not only examine regional variations in gender differences in learning outcomes but to also compare gender differences in developed, developing and transition countries. In developed countries studies show that boys have been performing better than girls in mathematics but the boys have recently lost the edge over girls on achievement tests in mathematics (Gwen et al, 2006). A wealth of research has documented differences in the academic achievement of boys and girls (Dwyer &Johnson, 1997; Entswisle et al, 1997; Hyde, Fennema & Lamon, 1990; Kimball, 1989). A study of gender differences in senior secondary mathematics has been explored in great detail with results indicating that males outperform females on external examinations (Lydeamore, 1993; MacCann, 1995; Stobbart, Elwood &Quinlan, 1992; Whitehouse & Sullivan, 1992; Willis, 1989).

Kakonge (2000) analysed the Kenya Certificate of Secondary Education (KCSE) data for 1990-1996. The findings revealed that at both national and provincial level, the averages of examination scores for boys were higher than those of girls. In general student performance in

the Kenya Certificate of Secondary Education (KCSE) in mathematics and science subjects by sex in the year 2000 was below 50%. In mathematics the national mean score was 42.3% for males and 26.8% for females exhibiting a gender percentage differential of 15.5% in favour of boys. Some authors have found that achievement differences are also influenced by single sex versus mixed sex schools and generally performance in mathematics favours single sex schools (Kahle and Meece, 1994; Levin, Sabar and Libman, 1991).

Competence in mathematics is paramount due to constant change in the global economy and workplace, use of mathematics for everyday decision making, the link between mathematics and other subjects and the intrinsic value of mathematical knowledge in every culture. Another factor that underscores the importance of mathematics is the fact that it is one of the two principal modes of engaging the world intellectually through words and numbers (Laidlow, 2004). The greatest indicator of intellectual power entails the faculty of combining words with numbers.

The research surrounding mathematics achievement in industrialized and developed countries sharply contrasts with that of developing countries. In the developed countries, gender gaps are less pronounced. Results of the Third International Mathematics and Science Study (TIMMS) show that there has been no constant gender gap at fourth and eighth year of schooling. A study carried out on the current status of male-female differences in achievement in mathematics revealed a rough parity in the percentage of boys and girls reaching proficiency in 2008 with boys edging out girls slightly in some states and girls doing better in other states.

In developing countries gender disparities in the performance of mathematics persist. Ridell & Nyagura (1991) found that at the secondary school level, the girls' achievement was significantly lower than that of boys particularly for mathematics. In Zimbabwe, the performance of boys in individual subjects was better than that of girls and it is further reported that girls did not perform well in mathematics. In Malawi, boys outperformed girls in the national examination. Fewer girls than boys passed with distinctions in mathematics (Kadzamira, 1987; 1988). And according to Mwanza (1990) the gap between girls' and boys' performance in mathematics has widened.

Among sixth graders tested in fourteen countries by the Southern and Eastern African Consortium for Educational Quality (SACMEQ) a significant male advantage in mathematics was present in Kenya, Mozambique, Tanzania, Zambia and Zanzibar (UNESCO, 2008). In Kenya a study carried out in four districts revealed that the mean difference between boys and girls in the performance of mathematics was 4.7% in Kiambu, 9% in Bungoma, 15% in Kisumu and 8.8% in Garissa. In Garissa, fewer girls than boys generally enroll in school and their achievement is generally lower than that of the boys. The greatest gender point differential occurred in Kisumu and Bungoma districts while the worst was Garissa because it had a mean score of 14.9% for boys and 6.1% for girls. Therefore, this means on average, 85.1% and 93.9% of boys and girls respectively failed mathematics (IPAR, 2003).

Patterson et al (2003) found that students' attitude to mathematics is gender related and that these differences in turn have the potential to affect mathematics performance. The results point to the fact that males tend to have higher mean scores on mathematics content and attitude. A study carried out on 140 female Ivorian students revealed that in mathematics there is a relationship between attitude and ability which is dynamic and interactive. Analysis of the t-test revealed significant differences in the high achieving group and low achieving group. The high achieving group reported less anxiety and more positive attitudes towards persistence and problem solving. The high achievers had more positive attitude towards the usefulness of mathematics than their low achieving peers (Frazier, 1999). 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 univer-

sity to train as doctors, engineers and architects while girls were only capable of being tailors, teachers and secretaries.

Other researchers suggest that the magnitude of gender difference may depend on many variables like the ability level of the student and socio-economic background among others. Achievement differences are also influenced by single sex versus mixed sex schools (Kahle &Meece, 1994; Levin, Sabar &Libman, 1991). Most mixed (co-educational) schools in Kenya are patronized by students from low socio-economic status backgrounds. In such schools, the government meets the full cost of tuition fees but the boys and girls only secondary schools are slightly more expensive because of boarding fees which the poor cannot raise. The Facilities in most mixed day schools are also insufficient as compared to those of boarding schools.

Goals of the Study

To establish the gender disparities in the performance of mathematics in KCSE during 2005-2009 in Western Province, Kenya. To investigate the factors influencing differential achievement in mathematics in Western Province, Kenya.

Significance of the Study

It is hoped that these findings will assist teachers and secondary school administrators address factors contributing to poor performance in mathematics. It is hoped that these findings will assist mathematics teachers improve their classroom practice and teaching-learning activities in order to create and sustain interest in the subject. The study will contribute to the stock of knowledge of factors contributing to disparities in achievement in mathematics.

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 in achievement in mathematics. It yielded information which was analysed using descriptive and inferential statistics. It is also appropriate in assessing the factors influencing achievement in mathematics.

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 mixed day schools. The study used Heads of Mathematics Departments in schools. There were 40 Heads of Mathematics Departments chosen as respondents representing the administrative authority in their respective departments in their 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.

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Instrument

The main data collection instrument in this study was the questionnaire. A special questionnaire was developed for the respondent to fill in information on their gender, the school type, mean scores in Mathematics during each of the five year period and factors contributing to the indicated performance trends. This questionnaire expected each respondent to give their perceptions of performance in the subject and how it can be improved. 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, Analysis of Variance (ANOVA) was used to test the difference between groups (boys' boarding, girls' boarding and 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 Mathematics is presented in tables.

Results of the Research

Out of the selected 40 schools, response was obtained from 32 schools giving it a response rate of 80%. Of the 32 secondary schools, 16 are provincial while 16 are district schools. Further classification grouped the schools into boys' boarding schools (8), girls' boarding schools (8) and 16 are mixed day schools (or co-educational). Data on performance in Mathematics was obtained from the respective Heads of Departments. 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.

Disparities in Mathematics achievement in KCSE between 2005-2009

Table 1 below shows the general disparity in Mathematics achievement among the different categories of schools during 2005-2009. The achievement is measured as a mean score. The highest possible mean score that a school can realise in the subject is 12.0 (A) while the lowest is 1.0 (E).

Table 1. Achievement in Mathematics among different categories of schools.

School category	Year					
	2005	*2006*	*2007*	*2008*	*2009*	*Average*
Boys Boarding	4.650	5.401	5.532	6.601	6.272	5.691
Girls Boarding	3.820	3.993	3.863	5.359	5.401	4.487
Mixed Day	2.030	2.214	2.001	2.496	2.647	2.278

The table reveals that there are disparities in achievement among the different categories of schools as well as gender. Boys' boarding schools had the highest mean average achievement

during the five years (5.691). The girls' boarding schools had an average mean of 4.487 while the mixed day schools had a mean average of 2.278. Most mixed schools have poorly equipped. In addition, there have been observations that boy-girl relationships affect performance. Boys' boarding schools had a steady improvement in achievement between 2005-2008 and then experienced a drop in 2009. The girls' boarding schools and mixed day schools realised an improvement in 2005-2006, experienced a drop in 2007 and the improved between 2008-2009. The boys' mean score of 5.691 translates into a grade C, while girls and mixed day schools were at D+ and D- respectively.

Analysis of variance on the performance in Mathematics among the different categories of schools during the five years is presented in table 2 below.

Table 2. ANOVA table on achievement in Mathematics among different schools in five years.

	Sum of squares	df	Mean squares	F	Sig
Between groups	69.040	2	34.250	17.774	0.0001
Within groups	56.234	29	1.942		
Total	125.364	31			

ANOVA shows that there was a significant difference in mathematics achievement among the different categories of schools (p- value = 0.0001) as shown in Table 2. The calculated F value of 17.774 is greater than the critical value of 3.33. The null hypothesis is rejected at the 0.05 level of significance. Comparison of performance between boys' boarding and girls' boarding schools shows that there is a significant difference in the means of the two groups of schools. Because a t observed value of 10.224 exceeds the t critical value of 2.131 the null hypothesis is consequently rejected at the 0.05 level of significance.

The two statistical tests above reinforce the findings in table 1. Boys post better performance in mathematics than girls and this gives them a better chance of pursuing courses that have a bias for mathematics at the tertiary level. With the recent raising of the minimum diploma qualification to C and a required mean of C in Mathematics, the low achievement for girls has serious implications for girls' advancement. Most girls and students from mixed schools get weak grades in mathematics and this is bound to affect enrolment in diploma courses.

Factors influencing achievement in Mathematics

Respondents were asked to indicate whether the performance in mathematics in their respective schools could be regarded as having been improving, declining, fluctuating or constant during the five year period. The table below shows the rating by respondents from the different categories of schools.

Table 3. Rating of Mathematics performance.

Maths Rating	Boys Boarding	Girls Boarding	Mixed Day	Total
Improving	7	5	8	20
Fluctuating	1	3	6	10
Constant	-	-	2	2
Total	8	8	16	32

The majority of the respondents felt that performance in mathematics in their schools was improving as indicated by 20 respondents representing 62.5% of the total respondents. Of these, almost all the respondents from boys' boarding schools rated achievement in Mathematics in their schools as improving. Half of the respondents from mixed day schools also rated their achievement in Mathematics as improving. This implies that even in cases where mean scores were still quite low, any minimal improvement realized was appreciated and influenced the rating. Only 2 (6.25%) respondents from mixed day schools found performance in their schools constant during the five years.

Since this study sought to establish factors influencing achievement in Mathematics, respondents were asked to indicate the extent to which a number of given factors influenced performance in their schools. To begin with, they indicated how lack of, or the availability sufficient text books influenced performance in Mathematics in their schools.

Table 4. Effect of text books on performance.

	Lack of books			Availability of sufficient books			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	9	10	1	20
Fluctuating	3	5	2				10
Constant	-	1	1	-	-	-	2
Total	3	6	3	9	10	1	32

Legend: V.L.Ext -Very Large Extend, L. Ext-Large Extend, Small Ext- Small Extend

The table above shows that provision of text books is one factor that affects performance in Mathematics. The respondents who rated performance of Mathematics in their schools as being on the upward trend also indicated that the availability of sufficient text books contributed to this trend to a large extent (19 or 59.4%). Those whose school experienced a fluctuation in performance blamed this on lack of sufficient text books (8 or 25%). Only 3 (9.4%) of the 32 respondents felt that lack of books did not affect performance in Mathematics. Responses from the various schools show that, 7 respondents from mixed schools attributed low achievement in mathematics to lack of adequate text books, while 7 and 5 respondents from the boys and girls schools respectively attributed good performance in mathematics to availability of text books. Those who felt that text books were not a crucial factor in achievement in mathematics were only 3 (two were from girls schools while 1 was from the mixed schools).

The respondents also indicated the extent to which attitude affects performance in Mathematics. The findings are presented in the following table.

Table 5. Effect of Learners' attitude on performance.

	Negative attitude			Positive attitude			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	7	10	3	20
Fluctuating	5	3	2				10
Constant	2	-	-	-	-	-	2
Total	7	3	2	7	10	3	32

Most respondents who rated Mathematics performance as improving also felt that this was largely due to positive attitude by learners as indicated by 17 (53.13%) of them. Only 3 (9.4%) felt that a positive attitude contributed to just a small extent. Where performance in the subject is fluctuating (It sometimes improved then declined and vice-versa) or declining, it was blamed on the learners' negative attitude as shown by 10 (31%) of the respondents. Responses from the various schools show that, 8 respondents from mixed schools attributed low achievement in mathematics to negative attitude by students while the other 8 attributed the minimal improvement realized in the subject to positive attitude. In the boys schools, 7 respondents attributed good performance to positive attitude while only one attributed poor performance to negative attitude. In girls schools 3 respondents attributed poor performance in mathematics to negative attitude while 5 attributed good performance to positive attitude by learners

The HODs were also asked to assess the extent to which they felt that the teachers' attitude influenced performance in the subject. The findings are presented in the table below.

Table 6. Effect of Teachers' attitude on performance.

	Negative attitude			Positive attitude			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	9	9	2	20
Fluctuating	1	7	2	-	-	-	10
Constant	1	-	1	-	-	-	2
Total	2	7	3	9	9	2	32

The teachers' attitude was found to have some influence on performance in Mathematics. For improving school, 18 (56.25%) respondents cited teachers' positive attitude while for fluctuating schools, 8 (25%) respondents cited teachers' negative attitude. However, 3(9.4%) of the respondents felt teachers' negative attitude did not affect performance in Mathematics.

Similarly, on the effect of learners' practice and performance, 16 (50%) respondents in whose schools performance in the subject was improving cited frequent practice as a factor contributing to the upward trend while 8 (25%) blamed fluctuation in performance on lack of practice by the students.

Table 7. Effect of learners' practice on performance.

	Negative attitude			Positive attitude			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	7	9	4	20
Fluctuating	5	3	1	-	-	1	10
Constant	2	-	-	-	-	-	2
Total	7	3	1	7	9	5	32

Responses from the various schools show that, 7 respondents from mixed schools attributed low achievement in mathematics to lack of lack of practice, while 7 and 5 respondents from the boys and girls schools respectively attributed good performance in mathematics to practice by students. In a way, more boys than girls therefore learn through the practice of problem solving.

Interest in the subject also influenced performance as indicated by 15 (46.88%) respond-

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ents of improving schools. 8 (25%) respondents of fluctuating schools said students lacked interest in the subject while 5 (15.6%) felt sustained interest contributed to just a small extent.

Table 8. Effect of interest by students on performance.

	Negative attitude			Positive attitude			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	4	11	5	20
Fluctuating	4	4	1			1	10
Constant	2	-	-	-	-	-	2
Total	6	4	1	4	11	6	32

Finally, respondents were asked whether previous performance in the subject had any influence on subsequent performance. The findings are tabulated below.

Table 9. Effect of previous performance on subsequent performance.

	Previous poor performance			Previous good performance			
Maths Rating	V.L. Ext	L.Ext	No effect	V.L. Ext	L.Ext	Small Ext	Total
Improving	-	-	-	3	13	4	20
Fluctuating	5	3	1			1	10
Constant	-	1	1	-	-	1	2
Total	5	4	2	3	13	5	32

In a way, success begets success. Schools that were rated as improving had also realized good performance in Mathematics during previous years and this certainly shaped the performance in the subject. Those with previous good performance (16 or 50%) felt this shaped subsequent performance in the subject and those with poor past performance felt this contributed to fluctuations in performance.

Discussion

This study found that boys' boarding schools had the highest mean average achievement during the five years (5.691). More boys have a positive attitude towards the subject as compared to girls. The girls' boarding schools had an average mean of 4.487 while the mixed day schools had a mean average of 2.278. The responses from mixed schools show that, an equal number of respondents attribute poor performance to negative and good performance to positive attitude. Despite the poor performance in mixed schools, there are respondents who noted that there was an improvement and this could account for the positive attitude identified by some of them. The boarding schools had a higher average mean score than the day mixed schools. ANOVA shows that there was a significant difference in mathematics achievement among the different categories of schools (p- value = 0.0001) as shown in Table 2. The calculated F value of 17.774 is greater than the critical value of 3.33. The null hypothesis is rejected at the 0.05 level of significance. This finding agrees with that of Kahle and Meece, (1994); Levin, Sabar and Libman, (1991). According to these authors, achievement differences are also influenced by single sex versus mixed sex schools. Performance in mathematics favours single sex schools. Probably, in mixed schools, girls might be timid and fear to compete with boys.

A comparison of performance between boys' boarding and girls' boarding schools shows that there is a significant difference in the means of the two groups of schools. Because a t observed value of 10.224 exceeds the t critical value of 2.131, the null hypothesis is consequently rejected at the 0.05 level of significance. This finding of wide disparities in gender in mathematics achievement concurs with findings from other studies. Boys tend to have higher mean scores on mathematics content and attitude (IPAR, 2003). Results of the t-test revealed significant differences in the high achieving group and low achieving group. Secondly, Dwyer &Johnson, (1997); Entswisle et al (1997); Hyde, Fennema & Lamon, (1990) and Kimball, (1989) found that there were differences in the academic achievement of boys and girls. A study of gender differences in senior secondary mathematics has been explored in great detail with results indicating that males outperform females on external examinations (Lydeamore, 1993; MacCann, 1995; Stobbart, Elwood &Quinlan, 1992; Whitehouse & Sullivan, 1992 Willis, 1989).

The fact that this study was carried out in a developing country explains the wide disparities in performance. This is because, while it is indicated that in developed countries there is near parity in the achievement of boys and girls in mathematics, in developing countries gender disparities in the performance of mathematics have been found to persist. According to Ridell & Nyagura (1991) at the secondary school level, the girls' achievement was significantly lower than that of boys particularly for mathematics. In Zimbabwe, the performance of boys in individual subjects was better than that of girls and it is further reported that girls did not perform well in mathematics. In Malawi, Boys outperformed girls in the national examination. Fewer girls than boys passed with distinctions in mathematics (Kadzamira, 1987; 1988). And according to Mwanza (1990) the gap between girls' and boys' performance in mathematics has widened.

The findings of this study also concur with other findings of studies carried out in Kenya in four districts which revealed that the mean difference between boys and girls in the performance of mathematics was 4.7% in Kiambu, 9% in Bungoma, 15% in Kisumu and 8.8% in Garissa. Kakonge (2000) analysed the Kenya Certificate of Secondary Education (KCSE) data for 1990-1996. The findings revealed that at both national and provincial level, the averages of examination scores for boys were higher than those of girls.

This study also sought to establish the factors influencing achievement in mathematics. Therefore the respondents rated the trends of their schools in mathematics performance. Most respondents who rated Mathematics performance as improving also felt that this was largely due to positive attitude by learners as indicated and the teachers. Where performance in the subject is fluctuating or declining, it was blamed on the learners' negative as well as the teachers' negative attitude. There is some agreement here with the findings of Patterson et al (2003). According to a study he conducted, students' attitude to mathematics is gender related and that these differences in turn have the potential to affect mathematics performance. Both male and female teachers have a negative attitude towards girls' abilities to perform well in mathematics and this explains their lower mean scores in mathematics compared to their male counterparts.

Similarly, on the effect of learners' practice and performance, most respondents in whose schools performance in the subject was improving cited frequent practice as a factor contributing to the upward trend while a few blamed fluctuation in performance on lack of practice by the students. Interest in the subject also influenced performance as indicated by 15 (46.88%) respondents of improving schools. 8 (25%) respondents of fluctuating schools said students lacked interest in the subject while 5 (15.6%) felt sustained interest contributed to just a small extent. These findings concur with those of Frazier, (1999) who found that, the high achieving group reported less anxious attitudes and more positive attitudes towards persistence and problem solving and more positive attitude towards the usefulness of mathematics than their low achieving peers.

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Conclusion

This study was carried out to establish disparities in the achievement of mathematics in KCSE during the period 2005-2009 among boys and girls boarding schools and mixed day schools in Western Province, Kenya. It also sought to establish the factors influencing achievement in mathematics in the various schools. Of particular interest was the availability of text books, students' attitude towards the subject, the teachers' attitude, practice by the students and interest in the subject. The findings reveal that there are wide disparities in performance among the different categories of schools as well as gender. Boys' boarding schools have a lead in achievement in mathematics. The boys averaged at a mean score of 5.691 during the five years while girls were at 4.487. The mixed Day schools had a low 2.278. Boys are therefore better placed to pursue careers that have a bias for mathematics and most of which are marketable as compared to the girls and students who enroll in Mixed Day schools. Among the factors mentioned as contributing to poor performance in mathematics are lack of sufficient text books, negative attitude by students and teachers, lack of frequent practice by students and the influence of previous poor performance. The reverse of the same factors were mentioned as positively affecting performance and leading to improvement.

Recommendations

Lack of sufficient text books was mentioned as a factor contributing to poor performance. It is therefore recommended that school administrators should provide sufficient text books and other learning materials required in the teaching and learning of mathematics in order to improve performance.

In schools with low achievement in mathematics, there should be a concerted effort by entire staff to change the attitude of students towards the subject and incentives given for any minimal improvement realized.

Time should be officially set aside for students to practice mathematics under peer supervision. Weekend afternoons and after prep sessions can be utilized so that students take meaningful breaks after studies.

Students should be encouraged to set short quizzes tailored along the KNEC examination format, prepare sample marking schemes and have the test administered. The marked should also be done by students so that they grasp the details required. This will help them practice and stimulate interest in learning the subject.

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