Investigation of Factors That Influence Syllabus Coverage in Secondary School Mathematics in Kenya

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Abstract

Mathematics plays a vital role in individual, national and global development. However, over the years mathematics has been one of the most poorly performed subjects in the Kenya Certificate of Secondary Education Examinations (KCSE). In an attempt to improve performance, great effort has been put into completion of the syllabus. This study was done in Kakamega South district, involving a total of 85 secondary schools. The main objective was to determine the percentage of the syllabus covered, and correlate it with student performance. 16 out of 85 schools were purposively selected and used in the study. The head teacher, the head of mathematics department, and two randomly selected mathematics teachers from each of the 16 schools took part in the study. In total there were 64 respondents. A descriptive survey design was adopted for the study, and data collected using three questionnaires. Correlation between syllabus coverage and student performance using Pearson's Product Moment Correlation Coefficient (PPMCC) was 0.8343. Furthermore, a One Way Analysis of Variance (ANOVA) was determined and confirmed that syllabus coverage has a significant effect on student performance in mathematics at KCSE level. Also, a number of factors were identified as being responsible for early, late or non-coverage of the coverage.

Keywords: Syllabus Coverage, Student Performance, Mathematics, Entry Behavior, Extra Tuition, Absenteeism, Resources.

Introduction

Mathematics has been recognized as one of the subjects which is vital in people's life, may it be in science, technology, business or in other walks of life. The main objective of teaching mathematics at secondary school level in Kenya is to produce persons who will be numerate, orderly, logical, accurate and precise in thought. It is emphasized that certain content in the syllabus be covered, and specific concepts and skills mastered by secondary school students. These content attributes are tested for by the Kenya National Examinations Council (KNEC) after four years (KIE, 2002). Some concepts and skills like measurement, statistics, scale drawing, and calculus are useful and are applied in other subjects like physics, chemistry, biology, and geography (KNEC, 2000a).

Four basic goals for teaching mathematics have been identified as: utilitarian, personal development, economic growth, and cultural values (Yara and Otieno, 2010; Xia et al, 2008; Scopes, 1973). Additionally, mathematics is used in all measurement activities, transport and communication manipulations, in management of organizations by preparing daily routines, timetables, and leave schedules.

It is a requirement in many careers and trainings (Aguele and Agwagah, 2007). Further, Baxton (1984) notes that, mathematics is the gate and key of science. Neglecting mathematics wreaks injury to knowledge due to the relative difficulty of quantifying and manipulating nature and its myriad of manifested phenomena. It is an international language expressed clearly and with precision (Baber, 2011; Dowling, 1998; Costello 1991; Durkin 1995). It uses an internationally accepted symbol system that has condensed meaning and is understood by all (Gasca, 2011; Presmeg, 2003; Githua, 2001). Thus, it facilitates trade transaction across boarders as units of quantification are understood universally. Mathematics is utilized in all cultural settings like patterning and timing of entertainment, construction of buildings, making of furniture, interior design, and decoration (Buschang et al, 2011; Bartholomew, 2000; Papic and Mulligan, 2007).

However, over the years, performance in mathematics has continued to show a downward spiral. Various researchers have identified factors that are believed to cause poor performance (Miheso, 2012; Manoah et al, 2011; Benson, 2011; Mji and Makgato, 2006). This include: teachers not using student- centered approaches, lack of experiments and practical modeling activities, and lack of professional exposures that could have articulated issues related to teaching of mathematics in secondary schools. Many teachers attributed this performance to negative attitudes by the students as well as a missing link between primary and secondary school mathematics. Lack of application of technology including computer use, lack of parental support, and lack of motivation by both teachers and students were also noted. Eshiwani (2001), points out that poor performance in Kenya is due to poor teaching methods, and an acute shortage of textbooks. The fact that as many as six students would share one text book in some schools makes it impossible for them to complete their home work.

As such, the follow up teaching is not built on the students' homework experiences. This will invariably delay the pace at which the syllabus will be covered, leading to poor performance. Tswani (2009) found out that learners and teachers commitment and motivation, learners career prospects, learners perceptions of peers as well as teachers' perceptions of learners all affect persistence for achievement in mathematics. Overall, application of sound teaching and learning principles fosters an environment where pupils are motivated to achieve their full potential.

The issue of the technical language use in teaching mathematics has been cited as contributing to poor performance in the subject (Nor et al, 2011; Adegoke and Ibode, 2007, Duncan, 1996). Wasike (2003) observes that poor performance is due to the difficult language used in the mathematics classroom. He says there are words which have a different meaning when used in common day English language compared to when they are used in mathematics. To improve performance, students need to understand the mathematical language in a more simplified form. Negative attitude of students, teachers and parents also contribute to poor performance (Githua, 2001). Onyango (2012), Shikuku (2009), and Dzama (2006) have established that these factors do not directly contribute to poor performance in mathematics. Instead, late or non-coverage of the mathematics syllabus contributes a lot to poor performance. This study intends to further identify factors that contribute to early, late or non-coverage of the syllabus.

The problem

Mathematics is inevitably utilized in many daily life activities and specialized activities. Yet it is still among the most poorly performed subjects at KCSE level. In an attempt to improve performance, some parents arrange and pay for extra tuition for their children, so that they may cover all topics within the syllabus. These topics include: Arithmetic, Algebra, Geometry, Statistics, Probability, Navigation etc. Concepts in these topics are tested at KCSE examinations. Parents hope that extra tuition will lead to early syllabus completion, freeing time for revision later on in the year. They hope that such revision will lead to good performance in national end of secondary school examinations. Three categories of syllabus coverage have been identified as early coverage, late coverage and none coverage of the mathematics syllabus. The link between rate of syllabus coverage and its effect on performance was investigated. Additionally this study endeavored to determine reasons for the various rates of mathematics syllabus coverage.

Objectives of the study

1. To investigate the relationship between syllabus coverage and student performance in KCSE mathematics.
2. To find out factors that affect mathematics syllabus coverage in secondary schools.

Research Design and methodology

A descriptive survey research design was adopted for this study. Information was obtained from records of the head teachers, the heads of mathematics departments, and the selected mathematics teachers from the sampled schools. Records of syllabus coverage and the corresponding students' national examinations performances for the years 2009 to 2011 were accessed. Factors affecting syllabus coverage were also determined via the appropriate questionnaire from the sampled schools.

The Sample

This study sought information on students who had completed KCSE between 2003 and 2007 in Kakamega South district of Western Province. The district had 85 secondary schools which were stratified into four categories according to performance. Four schools were randomly selected from each category. The four categories of schools were classified as follows: Schools that consistently showed good performance formed category **'A'**; Schools that consistently showed improvement in performance in the past five years formed category **'B'**; those that showed a consistent drop in performance over the past five years formed category **'C'**; lastly Schools that consistently showed poor performance over the past five years formed category **'D'**. Thus records on syllabus coverage and student performance were sought from 16 secondary school head teachers, 16 heads of mathematics departments, and 32 mathematics teachers from the district.

Table 1: Mathematics students' mean scores for schools in category 'A'

School	Mean score 2009	Mean score 2010	Mean score 2011	Average mean score
1	6.2889	6.0444	5.5945	5.9760
2	6.068	6.0878	5.1845	5.7800
3	5.9791	5.8770	4.9681	5.6081
4	4.8333	4.5000	5.0250	5.1110
Average mean score for schools in category '**A**'				5.6188

Table 1 above shows that the range mean performance in category 'A' schools over the three year period was 5.9760 to 5.1110 with a mean performance of 5.6188.

Table 2: Mathematics students' mean scores for schools in category 'B'

School	Mean score 2009	Mean score 2010	Mean score 2011	Average mean score
1	2.764	2.1622	2.4102	2.4455
2	2.500	2.500	2.8894	2.6316
3	2.3809	2.4275	2.4878	2.4321
4	2.0776	2.5000	2.0340	2.2039
Average mean score for schools in category '**B**'				2.4283

The mean performance of group 'B' was 2.4283

Table 3: Mathematics students' mean scores for schools in category 'C'

School	Mean score 2009	Mean score 2010	Mean score 2011	Average mean score
1	1.9000	2.5500	2.1276	2.1925
2	1.8250	2.0526	1.7200	1.8659
3	1.7730	1.4000	1.4324	1.5351
4	1.7368	1.7826	1.7333	1.7509
Average mean score for schools in category '**C**'				1.8361

The mean performance of group 'C' was 1.8361

Table 4: Mathematics students' scores for schools in category 'D'

School	Mean score 2009	Mean score 2010	Mean score 2011	Average mean score
1	1.6667	1.4857	1.3953	1.5159
2	1.5556	1.2500	1.0800	1.2952
3	1.5238	1.4214	1.2727	1.4059
4	1.3333	1.4742	1.3142	1.3739
Average mean score for schools in category '**D**'				1.3977

Group 'D' had the lowest mean performance of 1.3977

Research Instruments

Three questionnaires namely; the Head Teacher Questionnaire (HTQ), the Head of Mathematics Department Questionnaire (HODQ), and the Mathematics Teacher Questionnaire (MTQ), were used to collect data for the study. Items in the questionnaires were mainly concerned with school policy on syllabus coverage and comparison of the percentage of syllabus covered to corresponding mean scores. The questionnaires also sought factors that contributed to early, late or non-coverage of the syllabus. Reliability of the instruments was established by the test-retest method.

Two schools from Kakamega South district were selected for the pilot study and therefore were not included in the final sample of the study. Pearson's Product Moment Correlation Coefficient (PPMCC), r_{xy} was calculated for each instrument, and yielded the following results in Table 5 below:

Table 5: Pilot PPMCC, r_{xy} for the research instruments

	HTQ	HODQ	MTQ
School 1	0.9883	0.9989	0.9667
School 2	0.9913	0.9974	0.9805
Mean	0.9898	0.9982	0.9736

The results in Table 5 show that the instruments were reliable and could be used to collect data from the field (Chau, 1998).

Data Collection

Data relating to both syllabus coverage and mean score performance was collected by the researchers in the four cadres of schools for the years 2009-2011. In total 16 schools participated in the study.

Results and Discussion

The relationship between syllabus coverage and student performance in KCSE mathematics

The first objective for this study was to investigate the relationship between syllabus coverage and student performance in KCSE mathematics. Table 6 shows the percentage of syllabus covered by each category of schools and the respective mean scores.

Table 6: Percentage of syllabus covered and the resultant KCSE examinations mean score by categories 'A', 'B', 'C', and 'D' schools.

Category	Average % of syllabus covered in each category	KCSE average mathematics mean score in each category
A	100 %	5.6188
B	80% - 100%	2.4283
C	50% - 80%	1.8361
D	< 50%	1.3977

From Table 6, it is evident that schools' coverage of the syllabus correlates positively with performance in the national KCSE Mathematics examinations. The effect of syllabus coverage on student performance using PPMCC was ascertained and found to be 0.8343. This is greater than 0.5, showing that a positive relationship existed between syllabus coverage and performance at national examinations.

Furthermore, a One Way Analysis of Variance (ANOVA) was determined as is illustrated in table 7 below.

Table 7: One-Way Analysis Of Variance for coverage and performance

	Sum of squares	dF	*Mean square*	F	Sig
Between groups	43.910	3	14.637	232.812	.000
Within groups	.754	12	.063		
Total	44.664	15			

Table 7 shows that syllabus coverage has a significant effect on student performance at KCSE level mathematics. The F value was determined as 232.812 at alpha level 0.05, and a significance of 0.000. This determined value is greater than the table value of F (3,12) = 3.49, further confirming that syllabus coverage has a significant effect on student performance at KCSE level mathematics. The implication is that schools have to overcome factors that delay syllabus coverage, and impress those that hasten syllabus coverage if they hope to perform well at KCSE level mathematics.

Table 8: Mean score for school categories according to syllabus coverage

% of syllabus coverage	No. of Schools	Mean	Std dev	Std error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
100%	4	5.6188	.37038	.18519	5.024	6.2081	5.11	5.98
80 to 100%	4	2.4283	.17512	.08756	2.1498	2.7069	2.20	2.63
50 to 80%	4	1.8361	.27433	.13713	1.3996	2.2726	1.54	2.19
Up to 50%	4	1.3977	.09149	.04574	1.2521	1.5433	1.30	1.52
Total	16	2.8202	1.72558	,43140	1.9007	3.7397	1.30	5.98

Table 8 shows mean scores, standard deviations, standard error and confidence interval for the mean. The mean performance column further confirms that syllabus coverage affects student performance in mathematics. The results show that schools which cover the syllabus early have time to put into place a series of measures that will ensure good performance. All of them indicated that they conducted a guided thorough revision. This is in agreement with Merisotis and Phipps (2000) who found a similar effect of remediation on performance. Maina, Adoyo and Indoshi (2011) observe that time allocated for mathematics in Kenya secondary schools, is inadequate to cover the wide syllabus, which often leads to poor performance. Kananu (2011) found that there was inadequate syllabus coverage in Kenyan Public schools and whatever was covered was not done effectively, leading to poor performance in the subject. Waudo and Wawire (2004) have proposed several ways by which syllabus coverage in mathematics can be improved. The students are encouraged to do enough exercises from many sources.

In addition these schools have time to involve students in mathematics contests, symposia, and inter-school mathematics discussions. In this way mathematics anxiety is controlled leading to overall good performance (Venkatesh and Karimi, 2010; Kiefer and Sekaquaptewa, 2006). Similarly, mathematics interest is jerked up. The schools avail past papers and mock examinations from different schools for students' revision. Time is set aside over the weekends for mathematics discussions involving all mathematics teachers, guest speakers, all candidates and the school principal for moral support. Early coverage allows time for working on the students' self efficacy and mathematical self concept which are very important in developing self confidence and improving performance of individual students (Ferla et al, 2009; Pajares and Miller, 1994). In addition, Prophet and Badede (2009), found that children best learn in their mother tongue contributing to improved coverage of the syllabus in science, leading to improved performance. However, Ghani (2009) found that 68.1% of University students do not agree that syllabus coverage affects their performance in their final examinations. Good preparation and use of class time was thought to be the key to yielding good examination results.

Factors that affect mathematics syllabus coverage in secondary schools

Objective 2 of the study was to find out factors that affect mathematics syllabus coverage in secondary schools.

Table 9: Factors that contribute to early syllabus coverage.

Factors	Extra tuition	Student/Teacher entry behavior	Availability of resources	Team teaching	Other factors
Number of schools	14	5	9	4	11
Percentage of schools affected	87.50	31.25	56.25	25.00	68.75

Table 9 shows factors that contribute to early syllabus coverage. From the table, extra tuition and availability of resources play a great role in syllabus coverage.

Although the Ministry of Education has stipulated specific teaching times (to start from 8.00am to 12.30pm, then from 2.00pm to 4.00pm), in some schools, lessons have been created at additional slots (6.00 and 6.40am, then 1.00 to 1.40pm, and 8.00 to 8.40pm) for mathematics. More lessons are created on Saturdays between 8am and 12.30pm, and on Sunday from 2pm to 5pm. The form three and four students are also retained in school during the holidays for more lessons. This is in line with Maina, Adoyo, and Indoshi (2011) who observed that, the Kenyan mathematics syllabus is too wide, and time allocated for it on the time table is inadequate, thus the need for extra time for tuition. Similar views were observed by Ireson and Rushforth (2004). Dindyal and Besoondyal (2007) also found out that in Mauritius private tuition in mathematics is not only taken by weaker students in the subject but by students of all abilities.

These students undergo private tuition for reasons such as improving performance in the subject, being forced by parents to do so, for content enrichment, in order to discuss their difficulties on an individual basis, for the opportunity to practice more problems and in order to learn better problem solving techniques from the private tutors. The students reported that doing the same thing twice led to double explanation and exposure to different problem solving opportunities. The quality of explanations were thought to be better, clearer and simpler than those given in the normal class. They claimed that in contrast to the school where teachers are chosen for them, in private tuition the students choose the teachers based on the ability of the teacher. The most common practice by individual tutors was to complete the prescribed examination syllabus, independent of the school work done by the students. Mogari, et al (2009), who studied the South African mathematics supplementary learner also agrees with these findings. However, Wolf (2002) has shown that on the average, globally, students with no Extra-School Instruction performed better in mathematics than those who underwent private tutoring.

These findings are in agreement with Eshiwani (2001), who noted that the poor performance in mathematics in Kenya was mostly due to poor teaching methods and an acute shortage of text books. If the students have access to the variety of resources they are able to progress smoothly and complete their homework on their own. Poor syllabus coverage is also due to unqualified teachers in overcrowded, non-equipped classrooms (Mji and Makgato, 2006). This implies that availability of resources, particularly text books improves performance. Miheso (2012) notes that a student/text book ratio of 1:1 or 1:2, improves syllabus coverage, while a ratio of 1:3 and above slows down syllabus coverage, leading to poor performance in mathematics. Other resources that play a part in syllabus coverage include: access to calculators, mathematical tables, graph papers. Graphic organizers and visual aids are useful in allowing insight to be gained easily. The caliber of the teacher is also an important resource factor (Askew et al, 1997). The teacher's orientation and expectations are key to the amount of work that may be accomplished with the students in any given period. Otieno (2010) adds that extra tuition by teachers, maximum support by parents, high standard of discipline, exposure to past examination questions, good previous academic records and regular assessment will lead to early syllabus coverage, which will in turn lead to good performance.

The study determined that entry behaviour was a contributing factor to the rate of syllabus coverage. This is in agreement with Shikuku (2012) and Manapure (2011). Students who have mastered the basics and those who have a good grounding in the pre-requisite knowledge required for the content at hand will progress at a faster pace. Class-entry academic, attention, and socio-emotional skills as well as reading and math achievement were noted to lead to overall attention skills necessary for faster coverage of the planned work (Duncan, et al, 2007). Students' attitude, students' understanding and mathematics anxiety also fall in this group of behaviour that will affect rate of syllabus coverage (Jennison and Beswick, 2010). Team teaching was found to be useful in specialized content delivery and to effective syllabus coverage. In normal situations many teachers lack full expertise in all content areas. There is thus a need to ensure greater student exposure to diverse fields of knowledge and practice by teachers who are experts in those areas. The teachers divide content according to some criteria by which each is most comfortable with. In this way collaboration, ease of content coverage, and skill provision is ensured (Murawski and Dieker , 2004; York-Barr, et al, 2004). Using team teaching, content is covered through direct instruction at a pace that ensures that all material is presented. While agreeing on the need for team teaching as determined by this study, Cruz and Zaragoza (1998) point out that there is no universally accepted guidelines for teachers collaborating at class teaching. At its worst this technique of syllabus coverage may result in a series of independent and uncoordinated lectures. Rather than help the learners who seek to benefit from the coverage of the syllabus, the result may result in conflict and lead the students to work at cross purposes.

The study reported a category of "other Factors" which also contributed, mostly negatively to syllabus coverage. These included: Absenteeism, teachers workload, school discipline, time management, sickness, group discussions, and supervisory activities by heads of departments and institutions. The study found out that absenteeism by both the teacher and the students played a major role in non-coverage of the syllabus. The findings are in agreement with the determinations of Okuom, et al (2012). They determined that due to frequent flooding in Nyando district in Kenya, absenteeism of students led to low syllabus coverage, and therefore to poor performance. Kiveu and Mayio (2009) similarly attest to the role of absenteeism on syllabus coverage. Many students cited lack of fees as the reasons for absenteeism.

A substantial number of students indicated that absenteeism was just a habit that had been formed. Otieno (2010) concurs, saying poverty in some parts of the country leads to non-payment of fees, which leads to absenteeism and exodus of students leaving big fees balances as they migrate from one school to another. Understaffing and poor administration also de-motivates teachers causing non coverage of the syllabus and thus poor performance. Others reasons for both teachers' and students' absenteeism included involvement in school activities (games and sports, representing the school for choir competitions), or sickness all which agree with the findings of Lydiah and Nasongo (2009). The findings on how teachers' workload corresponded with syllabus coverage is supported by Ribeiro (2011), Egun (2007), and Lizzio et al (2002). Generally, school discipline was found to have an impact on the dedication by both teachers and students to complete the syllabus. Self discipline on the part of the pupils ensured that homework and additional exercises were done in time. Allen (2010), in agreement suggests that classroom discipline affects the learning transactions that will contribute to syllabus coverage. Discipline determines how time management is done in the various schools. Simatwa (2010) amplifies the role of time management by pointing out that it enables the teacher to adapt rapidly in demanding work environments, create effective classroom management and to operate as befits team work.

Conclusion

Students who cover the mathematics syllabus, have a better mean score than those who fail to cover the syllabus. Students, who cover the syllabus early in the year and spend more time on revision, have an even better mean score than those who cover the syllabus just before KCSE examinations.

The findings show that only 12.5% of the schools in Kakamega South district cover the mathematics syllabus by the end of term one. These were category '**A'**, schools that consistently showed good performance in mathematics. Secondly, 50% of the schools were found to cover the syllabus by the end of term two, in readiness for Mock examinations. Some of these schools were found in category '**A**' , some in category '**B**' and a few in category '**C**'. Finally, 31% of the schools were found not cover the syllabus. These were mainly found in category '**D**', schools that consistently showed poor performance in mathematics.

To cover the syllabus early in the year, both students and teachers had to put in extra tuition time for which the parents pay handsomely. Extra tuition, high standards of discipline, good previous academic records, regular assessment and exposure to external mock papers will boost student performance. Some schools use team teaching to ensure all topics in the syllabus are understood by all students. They also ensure both teachers and students are present in school and actually attend lessons. Some schools expel slow learners, and have a minimum mark that a pupil must obtain at Kenya Certificate of Primary Education (KCPE), for admission in form one.

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