THE EXTENT TO WHICH KENYA CERTIFICATE OF PRIMARY EDUCATION (KCPE) MATHEMATICS RESULTS PREDICT PERFORMANCE IN MATHEMATICS AT KENYA CERTIFICATE OF SECONDARY EDUCATION (KCSE):

A CASE OF NATIONAL SCHOOLS

A RESEARCH PROJECT REPORT
SUBMITTED TO THE INSTITUTE OF CONTINUING EDUCATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

MAY 2002

KENYATTA UNIVERSITY
DECLARATION

This is my original research study and the first of its kind. It has not been presented in any academic institution of learning.

KIHARA JOSEPH M

Date: 26th June, 2002

I have examined and approved this document for partial fulfillment of the requirements for Master of Education Degree in Curriculum Development of Kenyatta University

DR. MALUŞU, J. M.
CURRICULUM SPECIALIST, SENIOR LECTURER DEPARTMENT OF EDUCATIONAL ADMINISTRATION PLANNING AND CURRICULUM DEVELOPMENT
KENYATTA UNIVERSITY

Date: 26 June 2002
The study set out to investigate the extent to which Kenya Certificate of Primary Education (KCPE) mathematics examination results predict performance in mathematics at the Kenya Certificate of Secondary Education (KCSE). It focused on the national schools. To achieve this objective, the study examined such factors as:

- Skills and abilities tested in KCPE and KCSE mathematics examinations.
- Teaching techniques adopted by teachers at KCSE level
- Attitudes of students towards mathematics
- Gender of the student
- KCPE and KCSE mathematics performance.

Each of the above factors was examined in the light of their combined impacts on the overall KCSE mathematics performance.

The target population included all the 18 national schools in Kenya of which 10 are boys and 8 are girls’ schools. A sample of six secondary schools was selected at random, using stratified random sampling to proportionately represent the boys and girls school categories. Data was collected through questionnaires and interviews administered on students and mathematics teachers. Performance data was obtained from the six national schools students’ performance records on KCPE examinations and corresponding KCSE examinations. Both quantitative
generated. Quantitative data were subjected to statistical analysis using measures of correlation and the textual data were analyzed qualitatively.

The main findings developed from the study indicated that:

There is a strong relationship between the grade a student obtains in KCPE mathematics and the grade s/he obtains in the KCSE mathematics.

The predictive validity of KCPE mathematics examination results on KCSE mathematics performance is high and significant in national schools.

There is a progressive linkage between the content skills and cognitive abilities in mathematics at KCPE and those tested at KCSE level.

Variations in mathematics performance among students in national schools by gender is minimal.

Key recommendations made in this study are that:

Students with low performance grades at KCPE level require increased individual attention by mathematics teachers in order to excel in KCSE mathematics.

Teaching strategies used by mathematics teachers at KCSE level should be enhanced to strengthen understanding and performance.
ACKNOWLEDGEMENT

In this study I have expressed several ideas and factors from national and international researchers and educators. I have also used my teaching, examinations and textbooks writing experience acquired in a period of 25 years.

I would like to thank my lecturer and supervisor, Dr. Joseph M. Malusu, who has provided constructive criticisms and valuable suggestions towards the improvement of this document, and without whose help this document would not have been complete.

Kihara J. M. 2002
DEDICATION

This project report is dedicated to my family members for their undivided support, encouragement and patience during my study, data collection and report compilation.
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ABBREVIATIONS AND ACRONYMS:

KCPE :- Kenya Certificate of Primary Education
KCSE :- Kenya Certificate of Secondary Education
KIE :- Kenya Institute of Education

This is the curriculum development centre in Kenya

KNEC :- Kenya National Examination Council

This is the national examining body for schools.
Includes examinations for primary, secondary and tertiary education.

NCTM :- National Council for Teachers of Mathematics.
It is an American umbrella body charged with the responsibility of giving guidance for mathematics development, teaching and assessment across states.

8.4.4 :- Represents the current Kenyan system of Education:

8 years of Primary Education
4 years of Secondary Education, and
4 years of University Education.

The KCPE is done after 8 years of Primary Education; KCSE is taken after 4 years of Secondary Education.
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CHAPTER ONE

INTRODUCTION:

This chapter presents a general introduction to the problem which includes; background to the study, statement of the problem, objectives of the study, research questions, significance of the study, assumptions, scope and limitations, conceptual framework and definition of terms.

1.1 Background to the Problem

Mathematics is probably the only subject that is taught in practically every school in the world. One of the cardinal reasons for the persistence of the special place held by mathematics in the school curriculum world over is the "way in which it has been used as a screening device or 'filter' for entry to numerous professions" (ICMI, 1986: P. 11). In Kenya, there seems to be a general consensus that every child must learn mathematics. This view is held because at both primary and secondary levels the subject is to be offered by all students as a compulsory subject.

Perhaps this view is fine. Cockcroft (1982) points out that "it would be very difficult, perhaps impossible to live a normal life ... without making use of mathematics of some kind". Mathematics is seen as a useful subject due to its provision of a powerful, concise, precise and unambiguous means of
communication through the use of graphs, tables, charts, diagrams, and symbolic representation to explain physical phenomena or make predictions (Mutunga and Breakel 1987; Cockcroft, 1982). Its study acts as an exemplification of certainty. It is believed to possess the ability to keep development of reasoning power. It is taught in schools and to all students because it teaches learners to think and display sharpness of mind.

The grade in mathematics obtained by a candidate at Kenya Certificate of Secondary Education (KCSE) examination is one of the key considerations for admission to any University and other training institutions of higher learning. It is also the quality of the grade that determines the career one ventures into in life. According to the Ministry of Education (1993) Kenya, to be considered for admission to any public University, a candidate must have attained at one sitting a minimum average grade of C+ in the best 7 subjects including the three compulsory ones English, Kiswahili and Mathematics.

Due to the importance attached to mathematics in other fields of study in secondary schools like in sciences, economics, geography, business studies, technical subjects, and so on, and the fact that mathematics is compulsory at KCSE, selection of Form One students to join the school is done with a pointer at the mathematics grade obtained at the Kenya Certificate of Primary Education (KCPE) examination. It is believed that the better the grade, say A or B, the more chances are that the student will find it easy in learning secondary school mathematics and other subjects where mathematical concepts are needed.
Consequently the more chances are that the student will score a good grade in the subject at KCSE. It is therefore an important exercise to study how a good grade in mathematics at KCPE obtained by a student influences the grade in mathematics obtained by the same candidate at KCSE in the Kenyan system of education.

A KCPE mathematics examination paper comprises 50 multiple choice items constructed to cover the whole of primary school syllabus. Each item has 4 choices among which 3 are distractors and only one is the key. The correct choice (key) carries 2 marks whereas a wrong choice (distractor) earns zero. This is marked by the use of the computer. In preparation for the examination, pupils are vigorously involved in sitting for several mock papers set by the school teachers, past papers and other papers collected from several schools within the country.

Analysis of the performance arising from several such mock papers gives a predictor to the pupils and teachers as to the grade expected at KCPE. It should be noticed here that drilling into how to select the key is an art exercised by the teachers, to the extent that working backwards at times from the choices and eliminating the wrong choices is mastered. The drilling of pupils into making the right choice in the examination is given more prominence than the acquisition of concepts in the subject (Sommerset, 1972). Pupils' ability to guess the right choice is a skill learnt through the preparation for KCPE mathematics examination.
However at Secondary school, the student is faced with a different format of examination. This examination is in two distinct papers, Paper 1 (121/1) and Paper 2 (121/2) each with 24 open ended items. The two papers are deemed to have covered the syllabus requirement at KCSE. In each paper, section 1 has 16 compulsory short items with a total score of 52 marks. Section II has 8 long items each of 8 marks. A candidate is required to answer 6 items with a total of 48 marks. Each paper is marked out of 100 and the results from the two papers constitute the final mathematics grade for the candidate at KCSE (KNEC, 2001). It is this grade that this study attempts to analyze in relation to the grade a student had scored by the time s/he entered Form One. It would be important to also visualize other factors that might have influenced this grade within the four year secondary cycle. This information will be useful to educators in mathematics and curriculum developers in the sense that appropriate measures and decisions could be put in place towards the improvement and sustenance of the process of instruction at secondary level.

In the Daily Nation of 28th May, 1992, concern was raised that Kenya's Scientific and Technological potentials is drifting to waste because school managers are getting their priorities wrong. As a result, a pupil who scored straight A's in science and mathematics in the Kenya Certificate of Primary Education (KCPE) and showed promise of becoming a technology expert may end up scoring E in the Kenya Certificate of Secondary Education (KCSE) examination in four years time. This means that the pupil may never enter scientific career like medicine, engineering or information technology. The view by Wamahiu Muya in this
paper leads directly to the concern of this study in the sense that reasons leading to poor performance at KCSE in mathematics in spite of an excellent performance at KCPE level is a concern to parents and teachers. Why should this be the case when it is the same student? What happens when the student goes to secondary school? Is it the mathematics that changes or is it the fault of the teacher? These are some of the issues which should be addressed fully using empirical data.

1.2 Statement of the Problem:

The Government budget allocation to education is quite enormous. Part of this money is used in the development and improvement of mathematics education in schools. However, there is little evidence to suggest that this increased expenditure on education has any bearing on the performance in mathematics on the part of students at secondary level.

The entry behaviour of students into secondary schools as concerns mathematics require a careful study of the mathematics grade of the student at KCPE. The study to be carried out in this research project is on how this mathematics grade at KCPE is viewed as a predictor to the grade obtained by the same student at KCSE examination. Needless to say several factors featured in this study:

- The nature of examination items leading to the KCPE grade in mathematics.
- The strategies adopted by teachers in teaching secondary school mathematics
• The attitude held by students in learning mathematics at secondary level.
• The nature of mathematics examination at KCSE.
• The sex of students and performance in mathematics at KCSE.
• Importance of predictive power of KCPE in the situation of scarce secondary school places; social morality and equity in the development of human resources.

1.3 **Purpose of the Study:**

The purpose of this study was to investigate how the KCPE mathematics grade of a student on entry into secondary school acts as a predictor to the mathematics grade the same student obtains at KCSE examination. This study was carried out in National Secondary Schools of Kenya including those for boys and those for girls. The researcher set out to bring to the fore the need to consider the grade in mathematics at KCPE and that at KCSE in the attempt to rationalize the predictive aspect.

**Objectives of the Study:**

The specific objectives of the study were to:

1.3.1 Determine the predictive validity of performance in KCPE Mathematics for the years 1992 to 1996 on their performance in KCSE mathematics over the period 1996 to 2000.
1.3.2 Identify the skills and abilities tested in Mathematics at the KCPE and KCSE examination papers.

1.3.3 Find out gender differentiation in performance in Mathematics at KCSE among students in National Secondary Schools.

1.3.4 Investigate the relationship between teaching strategies adopted by teachers in National Secondary Schools and students performance in Mathematics at KCSE.

1.3.5 Assess the attitudes of students in National Secondary Schools towards Mathematics.

1.4 Research Questions:

The following research questions guided the researcher in this study:

1.4.1 To what extent does the performance in Mathematics at KCPE predict a students performance in Mathematics at KCSE?

1.4.2 Which skills and abilities are tested in Mathematics at KCPE and KCSE levels?

1.4.3 How equivalent are the skills and abilities tested in KCPE Mathematics examinations over the period 1992 to 1996?
1.4.4 How equivalent are the skills and abilities tested in KCSE Mathematics examinations over the period 1996 to 2000?

1.4.5 What relationship exists between the various teaching strategies used by teachers in National Secondary Schools and the students' performance in Mathematics at KCSE?

1.4.6 Is the performance of boys in Mathematics at KCSE comparable to that of girls in National Secondary Schools?

1.4.7 What are the attitudes of students in National Secondary Schools towards Mathematics?

1.5 Assumptions:

In this study the following assumptions were made.

1.5.1 National Secondary Schools have adequate, qualified and experienced mathematics teachers.

1.5.2 Physical facilities and learning resources are sufficient, adequate and properly utilized.

1.5.3 Students are given proper and useful guidance into the nature of careers commensurate with the Mathematics grade at KCSE.
1.5.4 National Schools select students from all parts of the country and therefore this research has a national representation.

1.5.5 KCPE and KCSE Mathematics grades match respective students under study.

1.5.6 The quality of instruction in National Schools are at par with respect to caliber of staff, teaching strategies, learning resources and social facilities.

1.5.7 KCPE and KCSE mathematics items have been set with equitable standards based on unchanging syllabuses.

1.6 Scope and Limitations of the Study:

1.6.1 It is evident that there are several factors that influence students' performance in mathematics at secondary school level. This study was restricted to the varying strategies of teaching mathematics and the attitudes of students towards learning of mathematics.

1.6.2 This study was restricted to National Schools, leaving out Provincial, District and Private Schools from which useful information would be gathered.
1.6.3 The main limitation experienced in the study was the accessibility level to performance data both for KCPE and KCSE results. This was slightly overcome by assuring the school administration of the confidence with which the data was treated by using letter names to represent school names.

1.7 Significance of the Study:

Mathematics is one of the many subjects in the school curriculum at both primary and secondary levels. However, due to its varied applications in other disciplines and future career choices there is greater pressure for students to succeed in it than in most other subjects. This usefulness is, however, perceived in different ways:

To many it is seen in terms of the arithmetic skills which are needed for use at home, in the office, in small business enterprises, workshops and in everyday life. Some people view mathematics as the basis of scientific development and modern technological innovations. It has a wide application in nearly every aspect of life such as in economics, commerce, accounting, industry and in advanced communication systems. All these perceptions of the usefulness of mathematics arise from the fact that mathematics provides a means of communication which is powerful, precise, concise and unambiguous.

With this importance attributed to mathematics, it is disheartening to note that mathematics is one of the subjects that is performed extremely poorly by students.
at KCSE examination (KNEC/KCSE Report, 2000). Previous research has not been able to pinpoint the exact causes of this dismal performance (Eshiwani, 1982; Gall, et al, 1997; Grimson and Pegg, 1995). This has prompted the researcher to seek further evidence through this study in explaining mathematics performance at KCSE level.

The results of this study will be useful in the following aspects:

- to the Kenya National Examinations Council (KNEC) in providing feedback regarding the predictive validity of KCSE and KCPE examinations with the view to improving the quality of the examinations.
- in providing feedback to schools and the Ministry of Education on the mode of selection.
- on the adequacy of using multiple choice examination items at KCPE as compared to other types of examination formats.
- on the propriety of using KCSE results as a basis for selection for further studies and training.

1.8 Conceptual Framework

Fig 1: A schematic presentation of variable relationships.

KCPE results - independent variable
KCSE mathematics performance - dependent variable.
Conceptual Model

Note: The backward arrows indicate that some variables are not mutually exclusive.

The performance of mathematics at KCSE level (P) can be said to have a functional relationship with the following factors:

- previous KCPE mathematics performance of students (p1)
- nature of examinations (n)
- teaching strategies (t)
- gender perceptions (g)
- attitudes towards mathematics (a)
This implies that

\[ p \rightarrow F(p, n, t, g, a) \]

Among other extraneous and intervening factors, the above variables can be argued to have a significant effect on KCSE final mathematics performance level.

1.9 Definition of Operational Terms

These are the variables, defined as used in this study

**Performance in mathematics at KCPE level.**

Attainment of pupils in mathematics after 8 years of primary education. This is defined as the independent ordinal variable. The values are measured in ordinal scale of performance grades, namely:


A is the highest attainable grade level and E is the lowest attainable grade level.

**Performance in mathematics at KCSE level**

Attainment of students in mathematics after 4 years of secondary education. In the study, this is the dependent ordinal variable. The values are measured in an ordinal scale of performance grades, namely


The point system allocates 12 points to grade A, and subsequently 1 point to grade E.
**Skills and abilities tested**

In this study, the content skills at KCPE level are derived from the basic core topics in primary mathematics. See Appendix IV. This is regarded as a nominal variable.

The content skills at KCSE level are derived from the core topics in primary mathematics, with additional and upgraded content scope necessary for the student progression in conformity with their maturation and abstraction.

The abilities tested at both KCPE and KCSE mathematics, basically represent the intellectual abilities in the cognitive domain (Bloom, 1956), namely: knowledge, comprehension, application, analysis, synthesis and evaluation.

**Teaching strategies**

In this study, this represents the approaches and procedures used in teaching mathematics, especially at the secondary level, namely: problem solving, group work, questioning techniques, use of examples, among others.

**Gender of Student**

This represents the male and female categories in the study. It is defined as a nominal variable.
Attitudes of students towards mathematics

This represents the students' perceptions, interests and feelings towards mathematics. In this study, this variable is measured in ordinal Likert's scale.

**Nominal definitions**

- **Gutman's Lambda correlation coefficient (\( \lambda \)):** A measure of correlation between nominal variables. In this study, it provides a measure of relationship between gender and performance (categories of performance grades).

- **Kruskal's Gamma Correlation Coefficient (\( \gamma \)):** Used in this study to measure relationship between ordinal variables; mathematics performance grades at KCPE and KCSE levels. It also provides a measure of predictive validity coefficient of correlation between the two variables.

- **Predictive validity coefficient:** This is a measure of the extent to which the results of students' performance in a future similar or related subject performance measure. It is used in this study, therefore to determine how KCPE mathematics performance predict KCSE mathematics performance for the same student.
• National schools: These are the best developed schools spread across the country, which admit students from all parts of the country. They normally consider students with better grades at KCPE. The schools are equipped with the best teachers, resources, and they usually produce the best results of KCSE examinations.

• Provincial schools: These are schools spread across the country but confined to admitting students within the province.

• District schools: These are schools developed through community effort and admit students who has average performance within the district.

• Private schools: These are high cost schools maintained by individuals or organizations and which admit students of varied achievement at KCPE.

• Public schools: These are schools run and supported by use of public funds, and includes national schools, provincial schools and district schools.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

The literature review addresses the major issues that relate to the objectives of this study. These include; students attitudes towards mathematics, mathematics standards, expectations and assessment in mathematics, pedagogical implications, strategies of teaching mathematics, assessment and evaluation in mathematics, performance in mathematics at KCPE and KCSE, qualifications of the mathematics teachers and gender performance in mathematics.

It looks at the views on the performance of mathematics which have been expressed by various researchers and educators. As has been observed in chapter one, mathematics is rated high in the school subjects because of its wide application in other fields of study and in career choice.

2.1 Students Attitudes Towards Mathematics:

Belge (1973) and Watson (1976) argued that students have negative attitudes towards mathematics as they move from lower classes to upper classes. Belge (1973) says that pupils' attitudes towards mathematics is usually positive in early years of primary schooling but this decreases as they progress to upper classes. This could be due to lack of a clear and harmonious link between the primary school syllabus and that of secondary school. This view is supported by Taiwo (1974) in his book Mathematics teaching in schools where he suggests that
students' attitudes towards mathematics decreases as they climb higher because most of them have a general belief that mathematics is a very difficult subject that can only be understood by bright and hard working students. Although both Watson's and Taiwo's seem to give a pointer as to why a student's excellent grade at KCPE in mathematics does not necessarily lead to an equally excellent grade in mathematics at KCSE, there does not seem to exist adequate research findings to support this. Moreover, it is not every student who slackens in the pursuit of mathematics competence as s/he progresses to higher levels.

Bell (1980) observed that:

> what we learn and how we learn it is very closely tied to our attitude about the school and the subjects that are taught.

Giles (1978) is on record as having said that:

> the image of mathematics has been that of an adult subject ... and it is all too easy for a child to be discouraged right from the start. If he misses the first essential steps, he will have great difficulties in catching up, even if his interest is awakened at a later stage.

Accordingly, a student's feeling and perception about mathematics is a major factor affecting his attainment and realisation of full potential. Once students are motivated, they will no doubt develop positive attitudes towards both the subject and the teachers; and this will lead to the understanding of what they are taught.

Moore (1972) sought to determine the interrelationship between self-concept and attitude towards mathematics, and academic achievement in the area of arithmetical competence, concepts and applications. "An attitude scale towards
mathematics was administered to 551 boys and 559 girls who were members of self contained classes. The attitude towards mathematics do influence achievement, but a reasonable position is to infer a cause-effect relationship between these variables.

Donavan (1967) stated that:

"it is the attitudes that our students develop which are likely to stimulate or stop further study of mathematics. It is the attitudes which we build that are highly involved in the learning and retention of our subject ... and it is often the attitudes you build that are the basis for your rank as successful teachers."

Psychologists (Skemp 1971, Bruner, 1966) and most educators (Cockcroft 1982, Taiwo 1972) are in agreement with Moore (1972) and Donavan (1967) in that attitudes play an important role in the learning process. Teachers and all those who are involved in the education of children have a heavy responsibility in helping to create favourable attitudes towards mathematics. If the attitudes of appreciation of mathematics is attained by the student then s/he enjoys the subject, gets satisfaction in understanding it and feels rewarded when s/he attains mathematical competence.

2.2 Mathematics Standards

When expectations include more than learning concepts, procedures, and their applications such as moulding students attitudes and beliefs about mathematics, assessment also should support that broader vision. Education standards underscores the importance of students becoming self-directed learners. The
ability to self-assess understanding is an essential tool. To do this, calls for opportunities for students to critique their own work. Students knowledge of mathematics grows over time. Expectations and assessments should be rooted in a common view of how students develop and how best to help them learn at different developmental stages. Expectations and assessments should be linked by an underlying rationale of mathematics content areas. Although the learning of mathematical concepts over time does not follow a strict order of events, students often need to grasp certain concepts and ideas in order to address more advanced ideas.

Webb (1997) in his paper determining alignment of expectations and assessments in mathematics and science education, suggests:

When expectations are that all students can learn to high standards, aligned assessments must give every student a reasonable opportunity to demonstrate attainment of what is expected. Expectations and assessments that are aligned will demand equally high learning standards for all students, while providing fair means for all students to demonstrate the expected level of learning. Even a slight variation in the wording of an item can alter performance. Rarely will one form of assessment be capable of producing valid evidence for all students. A student's ability to perform well on an assessment depends on a number of factors in addition to the level of knowledge, cultural, social background and experiences. This implies that expectations and assessments will be better aligned and more equitable if multiple forms of assessment are used. The challenge becomes developing and maintaining an aligned system with a variety of means of assessment which function together to reflect more accurately what students know and can do. Consistently low scores on an assessment of a particular learning goal may be the result of many factors including misplaced expectations, rather than poor instruction or lack of effort by students. Students may be developmentally unprepared to attain a particular expectation or the structure of the curriculum may keep them from attaining sufficient experiences to learn what is expected.
It takes time for patterns to form and be recognized. Assessments must achieve a high degree of match between what students are expected to know and what information is gathered on their knowledge.

2.3 Expectations and Assessment in Mathematics

The U.S. Department of education's explanation of goals 2000: Educate America Act, and the improving America's Schools Act (National Institute for Science Education, 1999; The University of Wisconsin Board of Regents) both say that

alignment of curriculum, instruction, professional development, and assessments are key performance indicators for states, districts, and schools that are striving to meet challenging standards. Alignment between assessment and expectations for learning becomes not only critical but also essential. Alignment among an education system's policy elements will strengthen the system and improve what the system is able to attain. Alignment is critical to helping an education system articulate and maintain its desired course and intensity. An aligned system is better able to focus its resources and thereby strengthen its capacity for making deep, meaningful changes in instructional decision making and practice.

Assessments are meant to gauge student's achievement and to indicate whether expectations are being met. Assessments can also be used to formulate policy, monitor policy effects, enforce compliance with policies, demonstrate accountability, make comparisons, monitor progress towards goals and/or make judgments about the effectiveness of particular programmes. There are however other important elements in any education system which include professional development, instructional materials, college entrance requirements, teacher and students certification, resource allocations and national standards.
The Act further says:

"To determine alignment between expectations and assessments is a difficult venture for several reasons:

- both expectations and assessments frequently are expressed in several pieces or documents making it difficult to assess.
- it is difficult to establish a common language for describing different elements of policy. The same term may have very different meanings when used to define a goal and when used to describe something measured by assessment.
- the policy environment in an education system can be constantly changing. New innovations realised through improved standards, content, technology and research on learning can contribute to the complexity of identifying expectations and assessment".

The National Council of Teachers of Mathematics (NCTM) Order Code: OP3 (National Institute for Science Education, (1999), The University of Wisconsin Board of Regents) categorises mathematics standards under the following processes:

- problem solving, communication, reasoning, connections, and procedures or routines. While the approval of making sense and teaching for understanding is almost universal, critics of the mathematics standards see the emphasis on applications, intuitive problem solving and active learning as prone to serious errors.

Further research work by Clune, Haimo, Roitman, Romberg, Wright (Occasional Paper Order Code: OP3 on commentaries on mathematics and science standards,
2001) cites serious problems in the standards and real classroom practice. They came up with the following conclusions:

- Problems and applications that are vague, overly complex, technically incorrect and surprisingly needlessly technical.

- Teachers who obviously do not understand the underlying mathematical or scientific principles and who completely overlook both gross errors and powerful insights of their students.

- An emphasis on applications and cross-disciplinary problem solving to the exclusion of core subject matter content".

The dominant impression that can be derived from the above standards and problems associated with them is the need to develop and implement specific curricula and teaching strategies in mathematics. This will enable the debate to shift from generalisations to concrete. The standards in essence needs to be transformed into workable teaching plans. Student achievement and not ideology or rhetoric is the whole essence of mathematics education.

2.4 Pedagogical Implications

Classroom practice greatly influence what students learn. Expectations and assessments can and should have a strong impact on these practices and should
send consistent messages to teachers about appropriate pedagogy. To judge the pedagogical implications on expectations and assessments requires more than simple content analysis. Any review must attempt to gauge the likely implications for classroom practice by directly asking teachers how they interpret expectations and assessments and how their classroom practice fit with them. (Romberg 1995, Zarinnia, and Williams, 1990; Cohen, 1990). The true test of performance is what happens in the classroom and this is a pointer as to why educators are now paying increased attention to the importance of involving students in scientific inquiry, hands on learning, and more authentic instruction (Newmann, Secada, and Wehlage, 1995). Assessments that would reflect a more passive type of instruction would be less aligned with those expectations. Alignment is achieved when the instructional practices and materials implied by expectations, and those implied by assessments are consistent.

According to Webb (1997) critical elements to be considered in judging alignment and its influence on pedagogy include:

- Engagement of students and effective classroom practices. Traditional forms of student assessment, and the constraints imposed by limits on time and other resources, may place an inordinate influence on the superficial acquisition of skills and facts. In this way, education systems can gravitate towards readily measured outcomes, instead of more complex but also more desirable outcomes, such as students being able to investigate, create models, or otherwise demonstrate deeper content knowledge.
Expectations and assessments need to work together to provide consistent messages to teachers, administrators, and others about the goals of learning activities. A case for academic standards for Illinois indicates that students should learn and contribute productively both as individuals and as members of groups (Illinois Academic Standards Project, 1996). The document further states that

if no part of the assessment system produces evidence of whether students are contributing productively as members of groups then teachers would receive conflicting messages about how much classroom time should be spent having students work in teams.

- Use of technology, materials and tools. This is vital to knowing and "doing" mathematics today. Students should develop skills and confidence using tools such as calculators and computers in their everyday lives (National Council of Teachers of Mathematics, 1991).

It is necessary to realize that when using the above criteria to judge the alignment of expectations and assessments in a system like that in Kenya, a sense of reality needs to be maintained; the available resources, the amount of time available, education policy guidelines and the importance attributed to the quality of grade obtained.

2.5 Strategies of Teaching Mathematics:

Gitonga (1990) stresses that

The potential of an educational system is directly related to the ability of its teachers. Hence the more qualified and better trained teachers are, the easier it is to effect curriculum implementation. No matter how distinguished the members of a project team are, how carefully structured a new course is, how brilliantly the
various educational media have been exploited, the success or failure of any innovation ultimately lies on the receptiveness and flexibility of the classroom teacher.

This suggests therefore that the mathematics teachers have to be conversant with various teaching strategies for different categories of students. Students exhibit different powers of understanding. For this reason, these varied individual differences will require different handling. Some are fast learners, others slow and yet others will require frequent repetition of the same concept in order for them to internalise.

Kibanza (1980) says:

It is often suggested that mathematics should be studied in order to develop powers of logical thinking, accuracy and spatial awareness.

The study of mathematics can certainly contribute to these ends but the extent to which it does so depends on the way in which mathematics is taught.

It is therefore important for the teacher to be well informed about what strategies to use for specific behaviours of students.

Watson (1976) suggested that:

mathematics teaching and learning must involve students active participation. This could be achieved by using varied strategies including problem solving. We notice that when the lesson is teacher dominated, the teacher largely uses the expository method instead of both expository and heuristic. Expository method does not involve the learners participation, whereas mathematics requires a lot of calculations, participation, motivation and practice.
Wamahiu Muya in the "Blackboard" of the Daily Nation October 11 1995 expressed shock at the rate at which standards are falling in the performance of mathematics both at primary and secondary levels. The article claimed that mathematics teachers were overburdened with other teaching subjects.

2.6 Assessment and Evaluation in Mathematics:

Assessment and Evaluation are essential components in mathematics education. They help in monitoring students' readiness for new learning, gives teachers feedback on the success of their strategies and approaches, and helps to plan new learning. Evaluation involves diagnostic assessment practices that enable teachers to discover difficulties in individual students. Assessment is expected to focus on what students know and can do and how they think about mathematics. Skills assessed should incorporate ability to communicate findings, to present an argument and to exploit an intuitive approach to a problem (Mathematics in the New Zealand Curriculum, Ministry of Education, 2002).

The document further stresses on the assessment by suggesting:

*assessment should as far as possible be integral to the normal teaching and learning programmes. This increases the range and quality of assessment which can be carried out for good diagnosis. Assessment should involve multiple techniques including written, oral and demonstration formats. Group and team activities should also be assessed.*

Assessment should also be undertaken to provide students and parents with an indication of a student's progress.
In his paper on assessment in the teaching of mathematics Grimison (1993) of University of Sydney says:

*With the attempt to change some traditional teaching practices, problems have emerged concerning the restructuring of assessment in Australian mathematics education. The increased emphasis on problem solving and group work has meant that traditional forms of assessment are inadequate.*

Modern and improved teaching strategies in mathematics education are a prerequisite to quality achievement on assessment in mathematics. Evaluating students performance is a process that involves making judgments and decisions based on interpretation of evidence for the purposes of goal setting and reporting. Teachers are prone to make decisions about effective instruction for a student or group of students, redirect efforts and establish future learning goals. When this is done and communicated to students and parents then evaluation becomes very effective.

Criterion-referenced evaluation compares each student's performance to established criteria rather than to the performance of other students. It is most appropriate for evaluating student performance in the classroom. Norm referenced evaluation compares one student's achievement to that of others and is based on normal distribution. It is appropriate for large scale system analysis. (Middletown Information Resource, learn @ exit 109.com, California, 2002). Both KCPE and KCSE are examples of norm referenced evaluations.
2.7 Performance in Mathematics at KCPE and KCSE:

More than any other subject taught in schools, mathematics require that the learner understands sequentially related and hierarchically organised system of prepositions which require continuous training of mathematics teachers and tireless practice of learners.

Kihara (1995), argued that as a result of poor foundation in mathematics at primary level, pupils who excelled in the examination (KCPE) performed poorly in the subject at secondary school level. This is because the pupils are drilled to aim at reaching the correct answer without necessarily understanding the mathematical process. When they reach secondary school and are left to think and reason mathematically on their own they cannot cope.

In principle all curricula and programmes of instruction can be evaluated in terms of several criteria. The National Council of Teachers of Mathematics (NCTM) in the Occasional Paper Order Code: OP3 lists the following questions towards the criteria of evaluation:

- What mathematical content is reflected?
- What efforts are made to ensure that the content is significant and correct?
- Does the curriculum engage the students in realistic and worthwhile mathematical activities?
- Does the curriculum produce a deep understanding of aspects of the subject matter that are important to know and to be able to do?
To these, the researcher would wish to add the acid test of equity in performance. The goal of equity is always twofold: increased access together with higher standards. Does the mathematics curriculum lower expectations and constrict opportunities for students at any range of performance and achievement?

Education officials, parents, teachers and students interviewed expressed concern over the poor performance in mathematics and called for strategies to reverse the trend. They expressed factors that contributed to poor performance as: inadequate facilities, lack of reference materials, burdensome syllabus, students negative attitude, and lack of motivation among teachers (Daily Nation Monday March 13, 2000 page 25 column 3-6).

This poor performance concern is the disturbing factor held by many scholars and parents. It is worrying because mathematics is useful in whatever career one chooses and without it some people's hopes will not be realised, as expressed in the East African Standard of 2/12/1999 page 9:

students who failed mathematics in Kenya Certificate of Secondary Education (KCSE) and would like to further their studies in sciences now have a chance to fulfill their dream. Loreto College, Msongari has introduced a 14 week bridging course in mathematics. The course aims at upgrading Secondary School leavers competence in the subject in order to attain the minimum requirements for science courses in tertiary institutions. It targets students who passed well in other subjects but did not get the minimum of C- to join science courses.
2.8 Qualification of the Mathematics Teachers:

The qualification of teachers is very crucial in determining the general performance of students in any educational system.

Rising et. al (1973) argued that

*most people have agreed that the first requirement for success in teaching mathematics is knowing mathematics. If we are to teach mathematics so that it is understood, so that it makes sense, so that it can be applied, we must have an adequate background in mathematics content. We must not be an articulate reservoir of misinformation. We need a reservoir of applications, historical side light, unusual problems - yes even tricks and puzzles - if we are to build appreciation, curiosity and loyalty to mathematics.*

This same view is expressed by Griffiths (1974). He quotes Alexander Wittenberg as having said that,

*No single issue is more important in teaching of mathematics, than that teachers should be men and women of genuine intellectual distinction. Everyone of the parameters which influence the recruitment of such teachers include selection, training, salary scale, teaching aids, class sizes, independence... must be a legitimate concern of those who care for excellence in the teaching of mathematics.*

From the preceding quotations, it is clearly evident that a mathematics teacher must have undergone the right training in the teaching of mathematics so that he can in turn impart the knowledge to the students. The teacher should, besides having the required qualifications for effective teaching, also possess more mathematical know how than that available in the text book in use in school.

Bell (1978) shares the same view where he argues that

*Every teacher should know and understand the mathematics contained in the textbooks which are commonly used in secondary school mathematics courses; but a good teacher will know much more mathematical content.*
In reviewing the 1993 KCSE, the Kenya National Examinations Council (KNEC) made the following observations:

*If the secondary school teacher is to impart knowledge and problem solving skills required by the secondary school mathematics curriculum to children, it is vital that at a minimum, he acquires this knowledge and skills while he is in college, whatever his mathematics background before coming to college was.*

It is therefore important to recruit people for teacher training colleges who have a strong mathematics background. A good background in mathematics leads to good teachers of mathematics. A strong teacher of mathematics is a big asset to a school. Once students have become comfortable in mathematics then they can spare time for other subjects, and also experience motivation and confidence in whatever else they do towards their examination preparations.

2.9 Gender and Performance in Mathematics

On gender equity in mathematics achievement, Elizabeth Fennema and Carole LaCampagne in their papers (http://www.nise.org.internet,<o:p>;http://www.nise.org.internet), argue that learning differences are diminishing, or if any differences do exist, they are unimportant. Females appear to hold more negative values about mathematics and their relationship to mathematics than do males, but there is some evidence that these differences are also decreasing. The questions they pose are; “What mathematics was being measured in tests where gender differences have been studied?” “How was the information about values obtained?” “Were female voices part of the data-gathering procedures?” Too often the research that has reported gender differences has provided an incomplete picture at best and has
only helped to perpetuate the belief that females are somehow inadequate in relation to mathematics.

Studies conducted on Kenya children by Eshiwani (1974) and Parker (1974) found significant differences favouring boys over girls.

Students need to live in the world of science and mathematics as it is presently the emphasis. This will enable them get better jobs, compete in the world market and prepare for the future. The problem is how to marry the culture that students bring to schooling with the outside world for which we want to prepare them.

According to Carole La Campagne in her discussion paper, Panel One (Internet)

Gender differences in mathematics achievement over the past twenty years have been decreasing, and a greater percentage of women are taking mathematics at college level. However, a smaller number of women majoring in mathematics are interested in teaching mathematics as compared to men, so this is not equitable. At the same time the number of women who go on to graduate school in mathematics is not increasing significantly. This shows why there are few women graduates who project themselves as mathematics models to children in secondary schools.
CHAPTER THREE

DESIGN AND METHODOLOGY

This chapter deals with the various methods used in collection and analysis of data. The population, sample selection and sampling techniques are described. The research instruments and their utility in soliciting information are constructed.

3.1 Research Design

The study adopted the survey design, which incorporated both descriptive research and correlational research. The rationale for using the survey design was based on the nature of the study and the objectives previously stated. In order to determine relationship between KCPE mathematics examination performance and KCSE mathematics examination performance, correlational research was considered appropriate. To examine the nature of students’ attitudes, strategies of teaching, among others, descriptive research was found suitable.

3.2 Population and Sample

The study targeted a total of 18 national secondary schools with a population estimate of 3600 students (Kenya Education Official Directory, 2000). Of the 18 national secondary schools 10 (55.6%) are boys’ schools and 8 (44.4%) are girls’ schools. The schools are located in various parts of the country.

From the above population, a sample size of 1255 (34.9%) students was
randomly selected using stratified random sampling for the study. This method was considered suitable to enable the researcher to represent proportionately the two gender categories (boys and girls) in the sample.

In the target population, the number of boys compared to the number of girls is almost double (ratio 2:1). Hence in order to maintain proportional representation of the population components in the sample, more boys schools than girls schools were used.

Among the 1255 students, 410 were girls and 845 boys. The purpose of using these numbers was to maintain approximate population representation of the gender categories.

The sample/design is summarised in table 1 below:

Table 1: Sample Design

<table>
<thead>
<tr>
<th>Type of School</th>
<th>Number in Population</th>
<th>Number in Sample</th>
<th>Proportion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy Schools</td>
<td>10</td>
<td>4</td>
<td>55.6%</td>
</tr>
<tr>
<td>Girl Schools</td>
<td>8</td>
<td>2</td>
<td>44.4%</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>6</td>
<td>100%</td>
</tr>
</tbody>
</table>

From the six schools included in the sample, performance data on KCPE and subsequent KCSE mathematics examinations were obtained from 1255 students. In addition, a total of 12 teachers, 2 from each school, and 24 form 3 students, 4
from each school were selected at random to provide the interview and questionnaire data.

The sample components were developed as shown in table 2.

Table 2: Sample Components

<table>
<thead>
<tr>
<th>School</th>
<th>Gender</th>
<th>KCPE</th>
<th>KCSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Boys</td>
<td>1992</td>
<td>1996</td>
</tr>
<tr>
<td>B</td>
<td>Girls</td>
<td>1993</td>
<td>1997</td>
</tr>
<tr>
<td>C</td>
<td>Boys</td>
<td>1993</td>
<td>1997</td>
</tr>
<tr>
<td>D</td>
<td>Girls</td>
<td>1995</td>
<td>1999</td>
</tr>
<tr>
<td>E</td>
<td>Boys</td>
<td>1994</td>
<td>1998</td>
</tr>
<tr>
<td>F</td>
<td>Boys</td>
<td>1996</td>
<td>2000</td>
</tr>
</tbody>
</table>

The table represents the sample components of 1255 students selected from various girls and boys national secondary schools at KCSE level. Performance records of all the selected secondary schools for KCSE and corresponding KCPE mathematics were obtained. The boys secondary schools and the girls secondary schools were selected at random from the target population of 18 national schools. The selected years of KCSE examination performance were relatively recent to represent the current status of examination performance in the selected schools.

In table 2 school A, records of KCSE mathematics performance (1996) were available from a complete sampling frame of students who sat the examination in
the year indicated. Correspondingly the same students’ KCPE examination performance (1992) data were available in a complete sampling frame in the schools’ records. This was necessary data for comparison of each student’s KCPE performance in mathematics (1992) and KCSE performance in mathematics (1996).

The same type of data was obtained for schools B, C, D, E, and F. From each school, an average of 200 students were selected, adding to a total of 1255; representing the sample size considered adequate in comparison to the total population size (34.9% of population).

The schools were named A, B, C, D, E and F as shown in table 2. This was necessary because of the need to maintain confidentiality of the names of the selected schools as requested by the school administrators.

3.3 Procedure for Data Collection

3.3.1 The study covered the KCPE examinations of 1992 to 1996 and results for candidates enrolled and completing KCSE in the selected National Secondary Schools in the years 1996 to 2000. Results were summarized for each cohort of secondary classes among their attainment, and compared to their earlier achievements in KCPE.
3.3.2 The respective KCPE and KCSE examinations were analyzed to establish the skills and abilities tested: Their content and predictive validities were also determined.

3.3.3 Interviews were conducted with senior mathematics teachers in the secondary schools in the study to elicit information on performances, motivation, attitude and tradition of the schools.

3.3.4 Questionnaires were administered to all mathematics teachers in each of the 6 schools, on teaching/learning strategies, teaching/learning resources available, facilities and students’ attitudes towards mathematics.

3.3.5 Interview schedule was organized and carried out with Form 3 students to establish their interest towards mathematics. They were also required to provide useful information on how they learn mathematics.

3.4 Research Instruments

The study used three types of instruments in addition to other methods of collecting information. These were as follows:-

3.4.1 Interview Guide

The interview guide was used to gather information from the senior mathematics teachers in the selected schools. The interview guide was made up of sections. Section one focused on background information about teachers i.e. age, sex,
qualifications and experience in teaching mathematics: Section two elicited information on teaching/learning strategies, assessments, use of teaching/learning resources and their availability.

Section three dwelt on the students attitudes, motivation and problems encountered by teachers in teaching and students in understanding mathematical concepts, applications and transition between primary and secondary mathematics.

3.4.2 Questionnaire for Mathematics Teachers

A questionnaire was developed and administered to all the mathematics teachers in the schools in the sample. This too consisted of three sections and elicited data similar to that sought from the senior teachers. This was necessary as it would validate data obtained from the senior teachers as well as to gauge the differences in approach and perceptions regarding teaching and learning of mathematics at the secondary school.

3.4.3 Interview Guide for Students

Focused group discussion with the sampled students obtained from each school was conducted using an interview/discussion guide. This focused on their experiences in their study of mathematics namely: depth of understanding mathematical concepts and applications, thoroughness of teaching, quantity and quality of assignments, frequency of assessments, marking, availability of learning resources, motivation (including guest speakers, career guidance) and exposure to examination requirements.
3.5 Validation of Instruments

3.5.1 Reviewed by panel of experts including the research supervisor.

3.5.2 Piloting using a school not in the sample.

A total of 4 students and 2 teachers were used. In validating the instruments, response data from the selected students and teachers were examined for consistency, relevance to the purpose of the study, and accuracy of the information required. A few items were found to be malfunctioning because they had erroneous data and hence removed or refined to improve their reliability and validity.

3.6 Procedure for Data Analysis

The instruments and procedures indicated in the foregoing section generated both qualitative and quantitative data. The relationship between the KCPE and KCSE examination performance was established using Kruskal's Gamma ($\gamma$) coefficient to measure relationships between KCPE grades and KCSE grades. Tabulation and contingency tables, frequency and percentage indices, were also used to summarize qualitative data. Together, these were used to supplement interpretations in addressing the individual objectives of the study.

In addition, to analyse the gender disparity in performance between boys and girls in mathematics at KCSE level, the Lambda ($\lambda$) coefficient was used. This is because of the nominal variable (gender).
In order to verify the significance of the relationship between KCPE and KCSE performance grades, the chi-squared ($\chi^2$) test was applied at 1% level of significance. The same was applied on the gender data.
CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1 Purpose and Scope of Data Analysis

This chapter presents the analysis of both quantitative and qualitative data derived from results obtained by students in KCPE mathematics examinations and KCSE mathematics examinations. It also gives an analysis of primary data obtained through interviews and questionnaires, administered to teachers and students, in the target population (national schools).

The purpose of analyzing this data are to:

- determine the predictive validity of performance in KCPE mathematics on the performance of KCSE mathematics.
- compare the skills and abilities tested in KCPE and KCSE mathematics examinations over five-year period
- relate the KCSE mathematics performance on gender
- examine appropriate teaching/learning strategies and resources used by mathematics teachers
- examine the students’ attitudes towards mathematics at the secondary level.

The analysis is basically a survey research characterized by correlation analysis of quantitative data and descriptive analysis of qualitative data.
4.1.1 Response Rate

The response rate in data collection represents the number of responses obtained from student performance records, questionnaires and interviews of students and teachers, compared to the expected total number of responses from the selected sample. The expected responses from student performance records was 1255, whilst those from teachers and students were 12 and 24 respectively.

The response rate on performance data both at KCPE and KCSE levels was adequate (100%) to provide a representative measure of the total national schools’ student population.

The response rate from the questionnaires and interview schedules was also found adequate (100%). All the 24 students representing the national schools (A to F) responded. At the same time all the 12 teachers from the 6 schools responded both to questionnaire and interview schedule.

On the basis of the above response rates, it can be inferred that the results developed from the study reflects a valid and reliable representation of the targeted population.
Table 3: The analysis of the response rate

<table>
<thead>
<tr>
<th></th>
<th>Expected sample responses</th>
<th>Actual responses</th>
<th>Response rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student performance data</td>
<td>1255</td>
<td>1255</td>
<td>100%</td>
</tr>
<tr>
<td>Teacher questionnaires and</td>
<td>12</td>
<td>12</td>
<td>100%</td>
</tr>
<tr>
<td>interview schedules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student interview schedule</td>
<td>24</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

4.2 Quantitative Analysis and Results

This section presents an analysis of quantitative data obtained which includes largely primary data. Firstly, one set of primary data represents performance results in mathematics by the targeted student population. This includes, KCPE mathematics performance results between 1992 and 1996 from the target secondary schools. It is the holders of these results who were to sit for the KCSE examinations of 1996 to 2000 respectively. Consequently the primary data includes KCSE mathematics performance results obtained by the same student between 1996 and 2000. Secondly, the other set of data analysed herein were obtained through the use of questionnaires and interview schedules on the targeted sample respondents.

4.2.1 Analysis of predictive validity of KCPE mathematics results on KCSE mathematics results.

The table 4 statistics provides a summary of scores obtained at various grade categories in KCPE mathematics and various grade categories obtained by the
same students after 4 years of secondary education. The purpose is to ascertain the predictive correlation of KCPE on the subsequent performance in KCSE. Computing the correlation coefficient between KCPE grade categories and the subsequent KCSE grade categories, Kruskal’s Gamma ($\gamma$) coefficient is considered suitable for the two ordinal variables. In this case, the independent variable is the KCPE grade and the dependent variable is the KCSE grade obtained by the same student. The focus is in determining how the grade obtained by the student in mathematics at KCPE predicts the grade in mathematics, the same student obtains at KCSE.

The primary data comprise KCPE and KCSE mathematics grades for 1255 students out of a population of 3600 in Kenyan national schools.

Table 4: Relationship between KCPE results and KCSE results

<table>
<thead>
<tr>
<th>KCSE Grades</th>
<th>KCPE Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C-</td>
</tr>
<tr>
<td>A -</td>
<td>0</td>
</tr>
<tr>
<td>A-</td>
<td>0</td>
</tr>
<tr>
<td>B+</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
</tr>
<tr>
<td>B-</td>
<td>0</td>
</tr>
<tr>
<td>C+</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>C-</td>
<td>0</td>
</tr>
<tr>
<td>D+</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>D-</td>
<td>6</td>
</tr>
<tr>
<td>E</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
</tr>
<tr>
<td>%</td>
<td>2</td>
</tr>
</tbody>
</table>

The KCPE grades are the independent variables whereas the KCSE grades form the dependent variables.
From the table the following observation can be made:

- For KCPE grade C- on entry into secondary school, 2 candidates scored grade C, 1 candidate grade D+, 4 candidates grade D, 6 candidates grade D-, and 10 candidates grade E at KCSE four years later. Similarly for KCPE grade A on entry into secondary school, 160 candidates scored grade A, 77 grade A-, 72 grade B+, 77 grade B, and 2 grade E at KCSE.

- The expectancy table is able to give a predictive probability of performance at national secondary schools in mathematics.

  The probability of a student scoring grade A at KCSE on entry into secondary school with an A grade at KCPE in mathematics is

  \[ \frac{160}{684} = 0.234 \]

  The probability of scoring grade E at KCSE on entry into secondary school with an A grade at KCPE in mathematics is

  \[ \frac{2}{684} = 0.003 \]

  This shows that the better the grade in mathematics a student has on entry into national secondary school, the more likely are the chances of the same student scoring a better grade at KCSE.

- From C- to B- mathematics grades at KCPE, there were no A grade at KCSE. However, from B to A grade at KCPE, there were 169 A grades
at KCSE. This shows that there were students with scores of between B and A- who scored an A grade at KCSE.

<table>
<thead>
<tr>
<th>KCPE mathematics grade</th>
<th>KCSE mathematics grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A are $\frac{160}{684} \times 100 = 23%$</td>
</tr>
<tr>
<td>A-</td>
<td>A- are $\frac{6}{170} \times 100 = 3.53%$</td>
</tr>
<tr>
<td>B+</td>
<td>B+ are $\frac{0}{117} \times 100 = 0%$</td>
</tr>
<tr>
<td>B</td>
<td>B are $\frac{2}{94} \times 100 = 2.13%$</td>
</tr>
<tr>
<td>B-</td>
<td>B- are $\frac{0}{80} \times 100 = 0%$</td>
</tr>
<tr>
<td>C+</td>
<td>C+ are $\frac{1}{43} \times 100 = 2.33%$</td>
</tr>
<tr>
<td>C</td>
<td>C are $\frac{1}{44} \times 100 = 2.27%$</td>
</tr>
<tr>
<td>C-</td>
<td>C- are $\frac{0}{23} \times 100 = 0%$</td>
</tr>
</tbody>
</table>

These results show that there is a link between the quality of the grade at KCPE with that at KCSE.
• Entry grade at KCPE scoring an A grade at KCSE.

<table>
<thead>
<tr>
<th>KCPE</th>
<th>KCSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>A-</td>
<td>A</td>
</tr>
<tr>
<td>B+</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>C+</td>
<td>A</td>
</tr>
</tbody>
</table>

This shows that the higher the grade at KCPE in mathematics at entry to a national secondary school, the better the chances of scoring a higher grade at KCSE. Any grade below B+ at KCPE does not contribute significantly to the achievement of a good grade in mathematics at KCSE level.

• In computing the measure of association between the two ordinal variables:

 KCPE: C-, C, C+, B-, B, B+, A-, A
 KCSE: A, A-, B+, B, B-, C+, C, C-, D+, D, D-, E the Gamma coefficient (γ) is used.

\[ \gamma = \frac{A - D}{A + D} \]

where

A: is the agreements that represents the positive expected relationship between the two variables KCPE and KCSE in terms of increasing values from E grade
at KCSE and C-grade at KCPE to A grade in both KCSE and KCPE (diagonal).

If the relationship were a perfect match, then the predictive correlation ($\gamma$) between KCPE and KCSE would be linear and close to 1.0.

$D$: is the disagreements against the expected match in values for both variables in an increasing order i.e. from C- in KCPE and A in KCSE to A in KCPE and E in KCSE (diagonal). This quantity represents the proportional reduction of errors. It implies that you do not expect a KCPE A grade to lead to KCSE E grade. In the data from table 4, there were only 2 students out of 1255 who showed this extreme disagreement;

$$\frac{2}{1255} \times 100 = 0.16\%$$

This percentage is not significant.

Thus the predictive correlation validity coefficient $\gamma$ is:

$$\gamma = \frac{A - D}{A + D}$$

$$\gamma = \frac{305865 - 75759}{305865 + 75759}$$

$$\gamma = \frac{230106}{381624}$$

$$\gamma = 0.6029$$

The correlation coefficient obtained through this method provides a measure of the extent to which KCPE performance grades can be used to predict KCSE performance grades for the same student. It therefore represents the predictive
validity coefficient of performance. In general terms, this measure predicts the score for a student in one test and a future score of the same student in similar or related subject. (Hopkins, K. D. and Stanley, J. C., 1981, Educational and psychological measurement and evaluation pages 96 to 100)

Interpretation of predictive validity coefficient

- The table shows that, out of the 1255 students used in this study, majority (68%) scored grades A or A- combined (54.5% + 13.5%) in KCPE mathematics. Only 5.5% scored less than C+ in the same subject at KCPE level.

- Among the 1255 students that sat for KCSE, 4 years later, 53.7% scored between C+ and A (9.3% + 8.6% + 7.8% + 7% + 14%) in mathematics. Conversely, 46.3% scored grades below C+.

- There is therefore a slightly higher concentration of performance in the upper grades than the lower grades.

- From the values in table 4, the predictive validity coefficient between KCPE mathematics performance and KCSE mathematics performance stands at $\gamma = 0.6029$. This indicates that there is a strong relationship between KCPE mathematics performance and KCSE mathematics performance. It further shows that the students KCPE performance in
mathematics predicts his/her performance in KCSE mathematics by about 60%, other factors held constant.

- It also shows that 60% of variations in students KCSE mathematics performance can be accounted for, by the previous performance in KCPE mathematics.

- The predictive validity coefficient is approximated at 60% while 40% can be attributed to other factors (mentioned later in this study as gender, teaching-learning strategies, teaching/learning resources and students attitudes towards mathematics).

Using the $\chi^2$ - test

At $\alpha = 0.01$ (level of significance)

The degree of freedom (d.f.) is

\[
d.f. = (c-1) \times (r-1)
\]

\[
= (8-1) \times (12-1)
\]

\[
= 7 \times 11
\]

\[
= 77
\]

The critical value of $\chi^2 = 112.329$ (from tables)

The computed value of $\chi^2 = 639.4$

$639.4 > 112.329$
This shows that the prediction coefficient is significant in 99% of the population.

The foregoing analysis of the extent to which the KCPE mathematics results predict performance in mathematics at the KCSE level concur significantly with what other researchers have determined in previous related studies.

In terms of correlation in student performance in mathematics between lower and upper levels, a number of psychologists and educators have emphasized the need for progressive step-by-step development of concepts and skills from one academic level to the next. Piaget's and Bruner's theories of intellectual development, of learner's thinking process and the acquisition of mathematical concepts emphasize linkage between students' previous knowledge, experiences and skills with his/her subsequent ability in mathematics. If previous skills and concepts were not adequately developed, later concepts and skills required could be affected, especially in mathematics. Brunner (1960) and Gagne (1970) contend that readiness is determined by previously learned knowledge and skills which are relevant to the new learning situation.

This study has shown that students who performed very well at KCPE had sufficient mathematical skills and abilities, and hence were better prepared to perform the same way at KCSE level.
4.2.2 **Comparison of KCPE and KCSE examinations in terms of skills and abilities tested.**

In any given test or examination, item construction require an analysis of skills and abilities to be examined including relevant content levels. The main purpose is to ensure high content validity of the test or examination. Content validity implies that the right skills and abilities are tested in relation to relevant content. Achievement of high validity in testing implies that reliability or accuracy of the test in measuring the required content and skills is also high.

This section therefore addresses the following research questions:

- Which skills and abilities are tested in mathematics at KCPE and KCSE level?
- How equivalent are the skills and abilities tested in KCPE mathematics examinations over the period 1992 to 1996?
- How equivalent are the skills and abilities tested in KCSE mathematics examinations over the period 1996 to 2000?

Table 5 presents a comparative table of specifications for KCPE mathematics examination taken in 1996 and the KCSE mathematics examination taken by the same students in 2000. The data in this table is derived from the KCPE (1996) and KCSE (2000) past examination papers.
Table 5: Content skills and cognitive abilities in KCPE and KCSE in 1996 and 2000 respectively

<table>
<thead>
<tr>
<th>SYLLABUS CONTENT TOPICS</th>
<th>KNOWLEDGE KCPE</th>
<th>KNOWLEDGE KCSE</th>
<th>COMPREHENSION KCPE</th>
<th>COMPREHENSION KCSE</th>
<th>APPLICATION KCPE</th>
<th>APPLICATION KCSE</th>
<th>ANALYSIS KCPE</th>
<th>ANALYSIS KCSE</th>
<th>SYNTHESIS KCPE</th>
<th>SYNTHESIS KCSE</th>
<th>EVALUATION KCPE</th>
<th>EVALUATION KCSE</th>
<th>KCPE Total %</th>
<th>KCSE Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td>15</td>
<td>30%</td>
<td>6</td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td>Measurement</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>24%</td>
<td></td>
<td></td>
<td>12</td>
<td>24%</td>
<td>4</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>10%</td>
<td></td>
<td></td>
<td>5</td>
<td>10%</td>
<td>6</td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>12%</td>
<td></td>
<td></td>
<td>6</td>
<td>12%</td>
<td>7</td>
<td>14.5%</td>
<td></td>
</tr>
<tr>
<td>Graphs</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2%</td>
<td></td>
<td></td>
<td>2</td>
<td>2%</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Trigonometry</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>6</td>
<td>12.5%</td>
<td></td>
</tr>
<tr>
<td>Commercial arithmetic</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>14%</td>
<td>2</td>
<td></td>
<td></td>
<td>7</td>
<td>14%</td>
<td>2</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Statistics and probability</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>8%</td>
<td></td>
<td></td>
<td>4</td>
<td>8%</td>
<td>4</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>Vectors</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>1</td>
<td>2%</td>
<td>1</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Transformation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>1</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Matrices</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>1</td>
<td>2%</td>
<td>1</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Navigation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>2</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Linear programming</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>2</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Area approximation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>2</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Elementary calculus</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
<td></td>
<td>0</td>
<td>0%</td>
<td>4</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>36</td>
<td>25</td>
<td>10</td>
<td>9</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>4</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>Total %</td>
<td>2%</td>
<td>2%</td>
<td>6%</td>
<td>2%</td>
<td>72%</td>
<td>52%</td>
<td>19%</td>
<td>0%</td>
<td>17%</td>
<td>0%</td>
<td>8%</td>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Descriptive Summary:

KCPE abilities tested:

- About 80% of the KCPE papers test the lower levels of students’ content skills and abilities in mathematics. The lower levels include: knowledge, comprehension and application.

- About 20% of KCPE papers test higher levels of students’ skills and abilities. The abilities tested is only limited to the analysis level.

KCPE major content skills tested:

- KCPE examinations evaluate primarily the basic concepts and skills in mathematics. These include:

  - number skills and knowledge 30%
  - measurement skills and knowledge 24%
  - knowledge of algebra 10%
  - geometrical skills 12%
  - commercial arithmetic 14%
  - graphs 2%

KCSE abilities tested:

At the KCSE level mathematics examinations, about 56% of the test items (both papers I and II) evaluate students abilities at the lower level;

  - knowledge 2%
  - comprehension 2%
  - application 52%
It is evidently clear that majority of the items examine the level of application (52%)

44% of the mathematics items at KCSE test students knowledge and skills in mathematics at the higher levels. These include:

analysis 19%
synthesis 17%
evaluation 8%

**KCSE content tested:**

KCSE mathematics examination provide more emphasis on the following content areas:

- Numbers: knowledge and application 12.5%
- Algebra: application, analysis and evaluation 12.5%
- Geometry: application, analysis and synthesis 14.5%
- Measurement: application, analysis and synthesis 8.3%
- Statistics and probability: application, analysis, synthesis and evaluation 8.3%
- Elementary calculus: application and synthesis 8.3%
- Trigonometry: application, analysis and synthesis 12.5%

**Interpretive summary**

As indicated in the foregoing analysis, KCPE mathematics examinations assess the achievement of basic skills, knowledge and understanding of mathematics
by primary school leavers. However, evidence of linkage between primary mathematics and secondary mathematics testing exists. The secondary KCSE mathematics examination demonstrates an attempt to reinforce and broaden basic skills acquired at the primary school level. Increased challenges are introduced to enable learners/students to pursue the subject at higher levels.

Table 6 examines the consistency of cognitive abilities tested in KCPE mathematics examinations, based on five years from 1992 to 1996. This represents the years that the target student population in this study took their KCPE examination. The percentages represent the proportion of the total number of items that focused on each cognitive ability level such as application.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>4%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Comprehension</td>
<td>14%</td>
<td>4%</td>
<td>10%</td>
<td>6%</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>Application</td>
<td>74%</td>
<td>74%</td>
<td>64%</td>
<td>66%</td>
<td>74%</td>
<td>70%</td>
</tr>
<tr>
<td>Analysis</td>
<td>6%</td>
<td>12%</td>
<td>20%</td>
<td>24%</td>
<td>18%</td>
<td>16%</td>
</tr>
<tr>
<td>Synthesis</td>
<td>2%</td>
<td>6%</td>
<td>6%</td>
<td>4%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

From table 6 it can be inferred that across the five years of KCPE mathematics examination, the application ability is given the highest emphasis (between 66% and 74%), a range of 8%. The distribution of scores is nearly symmetrical in accordance with the sampling of the cognitive levels. The highest cognitive
ability level, for KCPE mathematics papers is the application level which registers 70% on average.

Table 7, further presents an analysis of the consistency of cognitive sampling in terms of similarities in weighting across the five years of KCSE under study. It compares how close the various cognitive levels are tested each year.

### Table 7: KCSE analysis of consistency of intellectual levels – ability sampling.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Comprehension</td>
<td>8.3%</td>
<td>8.3%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Application</td>
<td>50%</td>
<td>41.6%</td>
<td>40%</td>
<td>45.8%</td>
<td>52%</td>
<td>45.8%</td>
</tr>
<tr>
<td>Analysis</td>
<td>27.6%</td>
<td>29.2%</td>
<td>37.5%</td>
<td>27%</td>
<td>19%</td>
<td>28%</td>
</tr>
<tr>
<td>Synthesis</td>
<td>8.3%</td>
<td>14.6%</td>
<td>14.6%</td>
<td>18.8%</td>
<td>17%</td>
<td>14.7%</td>
</tr>
<tr>
<td>Evaluation</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>8%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

From table 7 it can be inferred that for the five years of KCSE examination the application ability is highest. However, the distribution of cognitive levels is skewed negatively. There is more emphasis towards the higher cognitive abilities of analysis and synthesis in testing. The distribution of the abilities tested in the various levels across the five years is nearly consistent; for example in application ability, the range is 10.

In table 8, the major content topics in KCPE mathematics examination are analysed. The main purpose is to examine the balance of content topics in the examination and how the content selection has been consistent across the five...
years. The aim is to confirm the consistency and hence accuracy of the examination as a reliable instrument in measuring mathematics achievement.

Table 8: KCPE analysis of consistency of content sampling

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>28%</td>
<td>30%</td>
<td>30%</td>
<td>28%</td>
<td>30%</td>
<td>29%</td>
</tr>
<tr>
<td>Measurements</td>
<td>20%</td>
<td>22%</td>
<td>20%</td>
<td>26%</td>
<td>24%</td>
<td>22%</td>
</tr>
<tr>
<td>Algebra</td>
<td>10%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>Geometry</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Commercial arithmetic</td>
<td>24%</td>
<td>18%</td>
<td>20%</td>
<td>20%</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>Elementary statistics</td>
<td>6%</td>
<td>8%</td>
<td>10%</td>
<td>6%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 8 indicates that across the five years of KCPE mathematics examinations, there has been very little difference on the proportion of each content topic between the years. For example in “numbers”, the difference in weightings range from 0% to 2%. Similarly, “Geometry” has been allocated the same weighing of 12% over the five years.

In terms of balance or content sampling, the highest percentage allocation per topic has been represented by “Numbers” followed by “Measurements” and “Commercial arithmetic”. The least has been “Elementary statistics”.

Table 9 is a presentation of the content sampling from various KCSE examination papers for 1996 to 2000. It attempts to compare the consistency of the major topics in percentage weightings across the five years of KCSE.
Table 9: KCSE analysis of consistency of content sampling

<table>
<thead>
<tr>
<th>Syllabus Content</th>
<th>1996</th>
<th>1997</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>Mean (x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>10.4%</td>
<td>12.5%</td>
<td>12.5%</td>
<td>10.4%</td>
<td>12.5%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Measurements</td>
<td>8.3%</td>
<td>6.3%</td>
<td>4%</td>
<td>10.4%</td>
<td>8.3%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Algebra</td>
<td>16.7%</td>
<td>16.7%</td>
<td>16.7%</td>
<td>14.6%</td>
<td>12.5%</td>
<td>15.4%</td>
</tr>
<tr>
<td>Geometry</td>
<td>16.7%</td>
<td>18.8%</td>
<td>18.8%</td>
<td>14.5%</td>
<td>14.5%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Graphs</td>
<td>2%</td>
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<td>2%</td>
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<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>6.3%</td>
<td>12.5%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Commercial arithmetic</td>
<td>10.4%</td>
<td>12.5%</td>
<td>16.7%</td>
<td>14.6%</td>
<td>4%</td>
<td>11.6%</td>
</tr>
<tr>
<td>Statistics and probability</td>
<td>10.4%</td>
<td>8.3%</td>
<td>6.3%</td>
<td>6.3%</td>
<td>8.3%</td>
<td>8%</td>
</tr>
<tr>
<td>Vectors</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Transformation</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Matrices</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Navigation</td>
<td>6.3%</td>
<td>4%</td>
<td>6.3%</td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Linear programming</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>0%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Area approximation</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>2%</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>Elementary calculus</td>
<td>6.3%</td>
<td>2%</td>
<td>2%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 9 shows that the content selection from the 15 syllabus topics have been consistent for the five years of testing. The highest emphasis is placed on geometry 16.7%, algebra 15.4%, numbers 11.7% and commercial arithmetic 11.6% due to their application in other content areas and to real life situations.

From the foregoing analysis, it can be inferred that the sampling of content and abilities examined at the KCPE and KCSE examinations are adequately balanced in terms of testing skills and abilities of students at both levels. Similarly there is consistency across the five years used in the analysis. This shows that reliability and validity in testing are met. Hopkins (1981) contends
that a good measuring instrument must possess important qualities of validity and reliability. Firstly, he indicates that measuring, precision or consistency of examinations is a necessary condition for measurement. Further, validity of the same measurement instrument is viewed as a sufficient condition for testing. This analysis has established the consistency and validity of KCPE and KCSE examination across the years of study.

4.2.3 Relating KCSE mathematics performances to gender

Several issues about gender and performance in mathematics have been raised. It is therefore necessary to examine the significance of gender in determining performance in mathematics at KCSE level. This study raises the following research question:

Is the performance of boys in mathematics at KCSE comparable to that of girls in National secondary schools?

Table 10 presents a cross tabulation of gender of students and performance in mathematics at KCSE. The data in the table was derived from 707 students in the sample, of which 472 were boys and 235 were girls. The rationale for selecting the 707 students was that they all scored the same grade (A) in mathematics in KCPE examination. The purpose of the analysis was to determine whether the gender of a student is a major factor in performance differences at KCSE level.
Table 10: KCSE mathematics performance on gender for students who had scored A in mathematics at KCPE

<table>
<thead>
<tr>
<th>KCSE Performance Grades</th>
<th>Gender</th>
<th>Male</th>
<th>%</th>
<th>Female</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good A- and Above</td>
<td>Male</td>
<td>210</td>
<td>44.5</td>
<td>Female</td>
<td>33</td>
<td>14</td>
<td>243</td>
</tr>
<tr>
<td>Good C+ to B+</td>
<td>Male</td>
<td>198</td>
<td>42</td>
<td>Female</td>
<td>116</td>
<td>49.4</td>
<td>314</td>
</tr>
<tr>
<td>Average Below C+</td>
<td>Male</td>
<td>64</td>
<td>13.5</td>
<td>Female</td>
<td>86</td>
<td>36.6</td>
<td>150</td>
</tr>
<tr>
<td>Total</td>
<td>Male</td>
<td>472</td>
<td>100</td>
<td>Female</td>
<td>235</td>
<td>100</td>
<td>707</td>
</tr>
</tbody>
</table>

From table 10 inference can be made that:

- Out of 707 students who previously scored grade A in KCPE mathematics, 243 scored A or A- in KCSE. Out of these 44.5% were male students while only 14% were female.
- Conversely, 150 students scored below C+ in KCSE examinations. Out of these 36.6% were females while 13.5% were males.
- A higher frequency of male students scored in the upper grades and a lower frequency in the lower grade. Conversely, it shows a higher frequency of females in the low grades and a lower frequency in the upper grades.
- Computing the coefficient of correlation between gender and KCSE grades, Gutman’s Lambda (λ) coefficient is used.

\[
\lambda = \frac{\sum L_{yx} - L_y}{N - L_y}
\]

where \( L_{yx} \) is the number of cases in the largest cell within a given x category (gender category);
Ly is the number of cases in the modal y category (performance at KCSE) ignoring x.

\[ \sum L_{yx} = 210 + 116 = 326 \]

\[ L_y = 314 \]

\[ N = 707 \]

\[ \lambda = \frac{326 - 314}{707 - 314} \]

\[ \lambda = \frac{12}{393} \]

\[ \lambda = 0.03 \]

Interpretive summary:

- The correlation coefficient \( \lambda \) of 0.03 indicates a negligible disparity between males and females of the performance in KCSE mathematics. It indicates that the gender attribute alone, accounts only 3% of the variations of performance scores in mathematics at national schools.

Rationale/justification for using Gutman's Lambda (\( \lambda \)):

- The independent variable, gender, is a nominal variable (naturally dichotomized into males and females).

- The dependent variable, KCSE mathematics grade categories, is an ordinal variable but classified into standard qualitative descriptions of performance: Very good, Good and Average. Thus asymmetric Lambda
(λ) for classified ordinal variable (Grosof, M. S. and Sardy, H., (1985: 295).

- Lambda (λ) is used here to measure proportional reduction of error in prediction of a specified variable (performance at KCSE level) when gender is known. The statistic (λ) reflects the degree to which knowledge of the students’ gender (male or female) reduces errors in “predicting” the grade category the students’ performance in KCSE mathematics will fall.

- Lambda (λ) is directly analogous to $r^2$, the coefficient of determination (Kohout, F. J., 1974: 23).

**Explanation of Lambda (λ) application:**

As shown in table 10, a random sample of 707 students who obtained grade A in KCPE mathematics was drawn. Out of the 707, 472 were males and 235 were females.

Taking the three grade categories of performance in KCSE (with frequencies 243, 314 and 150), the best single “prediction” of performance would be the modal category (with highest frequency: 314).

This is to say that majority of students with grade A in KCPE mathematics would obtain grades between C+ and B+ (good performance) at KCSE mathematics. This group accounts to 44.4%. This prediction is accurate by
44.4% with errors of 55.6% (frequency 393). The prediction accuracy is improved if the gender of the student is known (the independent variable). With the knowledge of the gender categories, a more accurate prediction could be made. This is achieved by finding the modal KCSE performance category within each gender category. This indicates that:

- for males, the best prediction is grade A- and above (210): 44.5%
- for females, the best prediction is C+ to B+ (116): 44.4%
- the two yield a total of 326 (210 + 116) correct prediction cases out of 707
- errors 262 + 119 = 381.

**Test of significance of relationship between gender and KCSE mathematics performance**

<table>
<thead>
<tr>
<th>Test statistic</th>
<th>$\chi^2$ test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of significance</td>
<td>$\alpha = 0.01$</td>
</tr>
<tr>
<td>Degree of freedom</td>
<td>d.f. = 3</td>
</tr>
<tr>
<td>Critical value for $\chi^2$</td>
<td>= 11.34 from tables</td>
</tr>
</tbody>
</table>

Computed $\chi^2$ value = 84.46

84.46 > 11.34

The tests results indicates that the relationship is significant for 99% of the student population.

This study has, however, confirmed that although the gender factor is critical as a determinant of students' mathematics performance, it is not a very significant
influence in student performance at the national school level. Studies by Bonsen (1963), Jairus (1964), Eshiwani (1974), Parker (1974) and Fennema and La Campagne (2002), found significant differences between boys and girls in performance. This study shows that the gender factor in the national schools does not contribute significantly towards performance in mathematics at KCSE level.

4.3 Qualitative Analysis and Results

4.3.1 Strategies of teaching mathematics

This section examines the strategies used in teaching mathematics at the secondary school level and the impact on performance. An analysis of 12 mathematics teachers and 24 Form 3 students in the targeted national schools is made. Specifically, on the basis of mathematics teachers responses, the following variables are examined:

- teaching/learning strategies used in teaching mathematics
- teaching/learning resources used
- mode of assessment
- individual attention and support to students

On the basis of students' responses, the following variables are examined:

- perceptions on teaching strategies used
- use of teaching/learning resources
- frequency of assignments
• marking of assignments
• frequency of practice (opportunities)
• using past papers

Table 11 addresses the teaching strategies used in teaching mathematics at national school level. The data was obtained from the 12 questionnaires completed by teachers. This data represents the teachers’ responses on the type of teaching strategies they commonly use. Each teaching strategy in the table is ranked according to the total number of teachers who said they apply the strategy.

Table 11: Teaching/Learning strategies commonly used by teachers

<table>
<thead>
<tr>
<th>Teaching Strategy Used</th>
<th>Number of Teachers</th>
<th>%</th>
<th>Comparative Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>8</td>
<td>66.7</td>
<td>8</td>
</tr>
<tr>
<td>Use of examples</td>
<td>12</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Group work</td>
<td>8</td>
<td>66.7</td>
<td>8</td>
</tr>
<tr>
<td>Discovery</td>
<td>9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Programmed learning</td>
<td>1</td>
<td>8.3</td>
<td>10</td>
</tr>
<tr>
<td>Field trips</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Problem solving</td>
<td>12</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Discussion</td>
<td>11</td>
<td>91.7</td>
<td>3</td>
</tr>
<tr>
<td>Individual work</td>
<td>9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Demonstration</td>
<td>9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Questioning technique</td>
<td>9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Seminars</td>
<td>1</td>
<td>8.3</td>
<td>10</td>
</tr>
</tbody>
</table>

From table 11, the following observations can be made:

• Problem solving, discussion and use of examples are the most frequently used teaching strategies in teaching mathematics.
Demonstration, discovery, individual work and questioning techniques emerge as some of the commonly used approaches in teaching mathematics in secondary schools.

Group work and lecture strategies are used sparingly.

Very little, if not any opportunity is given to students to participate in mathematics seminars, programmed learning and field trips.

Table 12: Students' perception on teaching/learning strategies used.

<table>
<thead>
<tr>
<th>Students' Perception</th>
<th>Number of Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likes the teaching strategies</td>
<td>11</td>
<td>91.7%</td>
</tr>
<tr>
<td>Do not like the teaching strategies</td>
<td>1</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 12 presents the students’ responses about their perceptions concerning the teaching strategies used in mathematics teaching. 91.7% of the students confirmed their preference for the strategies used while only 8.3% did not.

It can therefore be observed that the variety of teaching strategies commonly applied by teachers as indicated in table 12 above had a positive impact on students’ performance in mathematics.

Table 13: Teaching/learning resources used by mathematics teachers

<table>
<thead>
<tr>
<th>Type of Teaching Resources</th>
<th>Number of Teachers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts</td>
<td>4</td>
<td>16.7%</td>
</tr>
<tr>
<td>Models</td>
<td>8</td>
<td>33.3%</td>
</tr>
<tr>
<td>Geometrical instruments</td>
<td>9</td>
<td>37.5%</td>
</tr>
<tr>
<td>Probability kit</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 13 indicates that 16.7% of the mathematics teachers use charts, 33.3% use models, 37.5% use geometrical instruments and 12.5% use probability kit when teaching mathematics.

The analysis shows that the most frequently used teaching/learning resources are geometrical instruments and models, that is, by about 1 out of every 3 teachers. These teaching resources often enhance the effectiveness of the teaching strategies, particularly demonstrations, question and answer, and linkage of mathematics to real life.

Table 14: Students response on teaching/learning resources in teaching/learning mathematics

<table>
<thead>
<tr>
<th>Use of Teaching Resources</th>
<th>Number of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching resources are frequently used</td>
<td>20</td>
<td>83.3%</td>
</tr>
<tr>
<td>Teaching resources are not frequently used</td>
<td>4</td>
<td>16.7%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 14 indicates that 83.3% of students acknowledge that mathematics teachers frequently use teaching resources in class. Only 16.7% of students expressed that teaching/learning resources are rarely used. The main implication is that majority of students accept they benefit from increased understanding of mathematics when the teaching/learning strategies are relevant and enhanced through application of suitable teaching resources. This conclusion validates teachers’ responses presented in tables 11, 12, 15, 16 and 17.
Mode of assessment of students' progress in learning mathematics

Table 15: Homework rates; comparative responses of mathematics teachers and students.

<table>
<thead>
<tr>
<th>Frequency of Homework</th>
<th>Number of Teachers</th>
<th>%</th>
<th>Number of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>11</td>
<td>91.7%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Weekly</td>
<td>1</td>
<td>8.3%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Rarely</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 15 indicates a high concurrence level between teachers and students on homework rate, at 91.7% and 100%, respectively. They concur that homework for mathematics is given on a daily basis. This provides an indicator of optimum practice levels accorded to the learning process in national schools. It is a common belief that opportunity for enhanced mathematics practice sessions improves performance, which explains why the national schools often excel in mathematics as evidenced by the KNEC examination results (1996 to 2000).

Table 16: Frequency of mathematics tests

<table>
<thead>
<tr>
<th>Frequency of Tests Given</th>
<th>Number of Teachers</th>
<th>%</th>
<th>Number of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>%</td>
</tr>
<tr>
<td>Weekly</td>
<td>3</td>
<td>25%</td>
<td>5</td>
<td>20.8%</td>
</tr>
<tr>
<td>Fortnightly</td>
<td>8</td>
<td>66.7%</td>
<td>16</td>
<td>66.7%</td>
</tr>
<tr>
<td>Monthly</td>
<td>1</td>
<td>8.3%</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
Mode of assessment of students’ progress in learning mathematics

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<th>Number of Students</th>
<th>%</th>
</tr>
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<tbody>
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<td>91.7%</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Weekly</td>
<td>1</td>
<td>8.3%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Rarely</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

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Table 16: Frequency of mathematics tests

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<tr>
<th>Frequency of Tests Given</th>
<th>Number of Teachers</th>
<th>%</th>
<th>Number of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>0</td>
<td>0%</td>
<td>0</td>
<td>%</td>
</tr>
<tr>
<td>Weekly</td>
<td>3</td>
<td>25%</td>
<td>5</td>
<td>20.8%</td>
</tr>
<tr>
<td>Fortnightly</td>
<td>8</td>
<td>66.7%</td>
<td>16</td>
<td>66.7%</td>
</tr>
<tr>
<td>Monthly</td>
<td>1</td>
<td>8.3%</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

70
From table 16, majority of students and teachers concurred that mathematics tests are conducted fortnightly. This tendency affords students continued exposure and experience in solving problems from topics covered.

4.3.2 **Attitudes of students towards mathematics**

A fundamental feature about students is that their ability to acquire, develop and apply mathematical skills and knowledge is greatly influenced by their attitudes and perception about the subject.

This section examines critical factors that impact negatively or positively on students' perceptions about mathematics. Key among them are:

- Students perception about mathematics teachers
- How students feel mathematics could be made enjoyable
- Relating mathematics to real life situations and experiences

Nearly all students interviewed in national schools indicated that they like mathematics. When asked to explain why they like mathematics, they presented four major reasons. Their responses were given in table 17.

Table 17 Reasons for liking mathematics

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interesting</td>
<td>9</td>
<td>37.5%</td>
</tr>
<tr>
<td>Challenging</td>
<td>4</td>
<td>16.7%</td>
</tr>
<tr>
<td>Supports other subjects</td>
<td>8</td>
<td>33.3%</td>
</tr>
<tr>
<td>Factual</td>
<td>3</td>
<td>12.5%</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 17 shows that 37.5% of the students like mathematics because they find it interesting. 16.7% like mathematics because they find it to be challenging. 33.3% like the subject because they recognize and appreciate its usefulness in supporting their learning of other subjects. 12.5% of the students like it because it is factual. This analysis shows that students in national secondary schools have a positive attitude towards mathematics.

Table 18: Mathematics teachers’ perception about student attitudes towards mathematics.

<table>
<thead>
<tr>
<th>Students' Interest in Mathematics</th>
<th>Number of Teachers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Interested</td>
<td>6</td>
<td>50%</td>
</tr>
<tr>
<td>Interested</td>
<td>4</td>
<td>33.3%</td>
</tr>
<tr>
<td>Fairly interested</td>
<td>2</td>
<td>16.7%</td>
</tr>
<tr>
<td>Not interested</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 18 shows that 50% of the teachers supported the view that students are very interested in mathematics. 33.3% said that students are interested while 16.7% indicated that students are fairly interested in mathematics. At national schools, there was no teacher who recognized any student not interested in mathematics. This scenario gives teachers the urge and motivation to maintain or improve mathematics performance by their students in national schools.

Table 19 presents teacher’s responses on a Likert’s Scale of 10 points one of which is indicated as follows:

“students are well motivated in learning mathematics”
The teachers were asked to determine how strongly they agree with the above statement, and their responses summarized in the table.

Table 19: Teachers’ perception about students’ motivation in learning mathematics measured in Likert’s scale

<table>
<thead>
<tr>
<th>Students are well motivated</th>
<th>Value</th>
<th>Number of teachers</th>
<th>Total value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree (SA)</td>
<td>5</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Agree (A)</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Undecided (UD)</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Disagree (D)</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Strongly disagree (SD)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>108</td>
<td></td>
</tr>
</tbody>
</table>

From table 19, it is evident that students at national schools exhibit high motivation in learning mathematics.

The total value = 108

Maximum value is \((5 \times 24) = 120\)

Level of motivation is \(\frac{108}{120} \times 100 = 90\%\)

90% of students in national secondary schools are found to be highly motivated in learning mathematics. This result underscores their high ranking in the KCSE mathematics examination.
Table 20: Students’ perception about mathematics teachers

<table>
<thead>
<tr>
<th>Students’ Perceptions</th>
<th>Number of Students</th>
<th>%age of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likes mathematics teachers and mode of teaching mathematics</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Appropriate teaching strategies are used</td>
<td>22</td>
<td>91.7%</td>
</tr>
<tr>
<td>Relating mathematics to real life experiences</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Practice using past papers</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Supportive marking of assignments</td>
<td>24</td>
<td>100%</td>
</tr>
<tr>
<td>Frequent discussion of performance with weak students</td>
<td>24</td>
<td>100%</td>
</tr>
</tbody>
</table>

From table 20, the following observation can be made:

- The teacher-student relationship is friendly and beneficial to the teaching and learning of mathematics.
- The teaching strategies employed by teachers helps to prepare students reasonably well for the KCSE mathematics examination.
- The teaching/learning resources used promote students understanding of mathematics.
- Mathematics finds direct application to real life situations and experiences.
- Students are exposed to the actual past papers which reflect the examination standards.
- The mode of marking displayed by teachers helps the students understand the mode of scoring expected of their solutions during the actual examination.
- Weak students are provided with remedial and individual attention by their teachers.
5.1.1 Relationship between KCPE and KCSE Mathematics Performance

There is a significant relationship between the grade a student obtains in KCPE mathematics and the one s/he obtains at KCSE mathematics. The study established that:

- The predictive validity of KCPE mathematics examination on KCSE mathematics performance is 60%.
- Among students who join national secondary schools, majority attain B+ in KCPE mathematics. More than 77% of these students attain grade B+ and above in KCSE mathematics.

5.1.2 Skills and Abilities Tested in KCPE and KCSE Mathematics

A comparison of KCPE and KCSE previous examination papers and mathematics syllabus indicate that:

There is a reasonable link between cognitive abilities and content skills in primary mathematics and secondary mathematics. This demonstrates a progressive development of mathematical abilities and skills as the student matures.

Whereas the key mathematics content skills tested at KCPE level include Number, Measurement and Commercial Arithmetic, those tested at KCSE level include Geometry, Numbers, Algebra and Trigonometry.

At the KCPE level, the dominant cognitive ability tested is Application while the dominant abilities tested at KCSE level are Application, Analysis and Synthesis.
5.1.3 Teaching/Learning Strategies and Resources.

The analysis arising from the teachers’ questionnaires and students’ interview schedules indicate that mathematics teachers in national schools apply a variety of teaching/learning strategies and resources which are supportive of students’ understanding of mathematics. On the basis of this finding, the study found out that:

- The most predominant teaching/learning strategies used by national secondary school mathematics teachers are: problem solving, use of examples, discussion, demonstration, individual work and questioning technique.

- 92% of students confirmed their preference of the teaching/learning strategies used by teachers.

- On teaching/learning resources 83% of students gave an assurance that teachers make use of teaching resources during instruction. The commonest teaching/learning resources used are; mathematical instruments and models.

- There was a near agreement between teachers and students on the frequency of homework/assignments. 91.7% of the teachers give homework daily while 100% of the students said that they are given homework daily.

- 66.7% of teachers and 66.7% of students indicated that mathematics tests are given frequently.
5.1.4 Attitudes of Students towards mathematics

Nearly all students interviewed indicated that they like mathematics. On further probing they gave several reasons for their liking the subject. 37.5% like mathematics because they find it interesting. 33.3% like it because it supports other subjects that they learn. 16.7% like the subject because it is challenging and only 12.5% of the students indicated that they like it because it is factual.

Teachers were in support that students have a positive attitude towards mathematics. 50% of the teachers indicated that students are very interested, 33.3% indicated that students are interested, and 16.7% said that students are fairly interested.

Teachers’ perception about students’ motivation in learning mathematics as analysed using Likert’s scale indicated that 90% of the students at national schools exhibited high motivation in learning mathematics.

At national schools the relationship between students and teachers is friendly. 100% of the students like their teachers. 91.7% suggested that teachers make use of appropriate strategies, 100% said that teachers are able to relate mathematics to real life. Students unanimously agreed that they practice using past papers, teachers mark their assignments and tests regularly, and that weak students are given remedial help by teachers.
5.1.5 Gender and KCSE Mathematics performance

Gutman’s Lambda correlation coefficient was used to establish the relationship between gender and mathematics performance at KCSE level. The analysis results indicated that:

- Whereas the best predictive grade for males is A-, that of females lies between C+ and B+.
- The correlation coefficient indicates that there is a negligible disparity of 3% in favour of males, at national school level.
- The test of significance at 1% shows that the gender disparity is negligible.

5.2 Conclusions

Based on the results of the study, it can be concluded that: the better the mathematics grade a student scores at KCPE, the better the grade the same student will obtain at KCSE level. Conversely, the lower the grade attained by a student at KCPE level, the lower will be the grade the same student obtains at KCSE level. The current situation in national schools is that majority of the students admitted had excellent grades at KCPE level which demonstrates strong background in basic mathematics content, skills and abilities. This in turn promotes their capacity to attain high mathematics grades at KCSE level.

The Kenya National Examination Council (KNEC), the national examining body for schools plans and designs mathematics examinations which are based
on standard planning procedures that achieve high levels of validity and reliability. This study has established that mathematics examinations at both KCPE and KCSE levels have uniformity and consistency in content selection, cognitive skills and abilities sampling. This underscores the rationale used in this study to compare KCPE mathematics performance to the subsequent KCSE mathematics performance as an index of prediction.

Other factors that may affect the accuracy of KCPE performance as a predictor of KCSE mathematics performance include teaching/learning strategies and resources, students’ attitudes towards mathematics, and gender to some extent. The teaching/learning strategies and resources used to teach mathematics at the national schools have been found through this study to contribute towards students’ motivation, positive attitudes towards mathematics and achievement of high mathematics grades at KCSE level.

Although studies indicated that gender contributes significantly towards disparity in mathematics at various levels, the picture portrayed by this study for national schools does not reflect significant difference in performance. This study has established that KCSE performance in mathematics can be said to be a function of KCPE mathematics performance; content, skills and abilities tested, teaching/learning strategies and resources, and students’ attitudes towards mathematics at national secondary schools level. Although the results are conclusive for the situation in national schools, some questions still remain unanswered adequately. These include:
• The extent to which teaching/learning resources influence the level of achievement in mathematics at KCSE level.

• The significance of relationship between the level of students attitudes towards mathematics and student performance in mathematics at KCSE level.

5.3 Recommendations

Based on the findings of this study, the following recommendations are made:

5.3.1 The results of data analysis indicate a strong correlation between KCPE mathematics performance results and KCSE mathematics performance results. However, there are higher grade levels at KCPE than at KCSE. To maintain and improve KCSE mathematics performance, the teaching/learning strategies and resources at secondary school level should be enhanced to strengthen the quality of performance comparable to that at KCPE. This can be achieved by using modern technology in teaching mathematics. This view is held by NCTM (1991) which emphasizes the use of appropriate technology as vital in doing and knowing mathematics.

5.3.2 The emphasis in the teaching/learning process and measurement of mathematics achievement is geared towards excelling in final examinations (KCPE and KCSE). However, this might not provide a solid base to life-long mathematics aptitude and applications. The
evaluation of mathematics achievement needs to be a continuous process during instruction. Newman, et al (1995) points out that the true test of performance is what happens in the classroom. This serves as a pointer as to why educators are now paying increased attention of involving students in scientific inquiry, hands on learning and more authentic instructions.

5.3.3 Although the results of this study indicate that majority of students had positive attitudes towards mathematics, little evidence was availed on the use of more motivating strategies in making students become increasingly motivated in learning mathematics. There is need, therefore, to expose students to enriched opportunities that stimulate their interest in learning mathematics by using programmes such as field trips, seminars, conferences and workshops. Taiwo (1974) argue that the positive attitudes towards mathematics tends to decrease as students move from lower levels to upper levels. Donavan (1967) and Moore (1972) say that the attitudes that students develop towards mathematics do stimulate and influence achievement.


Mutunga and Brekel (1987). Mathematics Education. Kenyatta University


Nation Newspaper "Blackboard" October 11, 1995.


APPENDIX 1

TEACHER INTERVIEW SCHEDULE

1. Age ______________________

2. Sex: Male ☐ Female ☐

3. Qualifications:
   BED ☐ BSC/BA ☐
   Diploma ☐ Other ☐

4. Teaching Experience
   Over 12 years ☐ 8 - 11 years ☐
   3 - 7 years ☐ 0 - 2 years ☐

5. What is your workload per week?
   28 periods and above ☐ 23 - 27 ☐
   15 - 22 ☐ Below 15 ☐

6. Are you teaching other subjects apart from mathematics?
   Yes ☐ No ☐

7. What other subjects are you teaching?
   Physics ☐ Chemistry ☐
   Geography ☐ Biology ☐
   Others; Specify ____________________________

89
8. How many periods in other subjects?

- 12 periods and above
- 8 - 11
- 5 - 7
- Below 4

9. Do you use teaching resources in teaching mathematics?

- Yes
- No.

10. If yes, what are some of the teaching aids that you use?

- Charts
- Geometry Instruments
- Models
- Probability kit
- Other; Specify

11. If No, why?

__________________________________________________________________________

12. What methods do you use in teaching mathematics? Tick as many as you use.

- Lecture
- Problem solving
- Use of examples
- Discussion
- Group work
- Individual work
- Discovery
- Demonstration
- Programmed learning
- Questioning technique
- Field trips
- Seminars

Other; Specify
13. How often do you give homework to your students?
   - Everyday
   - After the topic is over
   - After two days
   - Weekly

14. After how long do you give the marked homework to students?
   - The following day
   - After two days
   - After one week
   - Students exchange notes for marking

15. How often do you administer mathematics tests?
   - After one week
   - After two weeks
   - After three weeks
   - After one month

16. Where do you enter the scores after marking?
   - Class progress record
   - Class list
   - A prepared book
   - In an exercise book

17. Do you have a record as to how your students had scored at KCPE in mathematics?
   - Yes
   - No.

18. Does this grade agree with students progress?
   - Strongly agree
   - Agree
   - Undecided
   - Disagree
   - Strongly disagree
19. Why do you think there is a difference in correlation between the KCPE grade and the progress record of students?

- Methods of teaching
- Nature of marking
- Student has relaxed
- I have no idea

20. Do you have sessions to discuss individual performance with weak students?

- Yes
- No.

21. How often do you discuss progress?

- Quite often
- Often
- Occasionally
- Not at all

22. Do you associate mathematics to real life experiences as you teach?

- Quite often
- Often
- Rarely
- Not at all

23. Do you discuss with your students about job opportunities vis-a-vis the quality of the mathematics grade?

- Quite often
- Often
- Rarely
- Not at all

24. How much do you like teaching mathematics?

- Very much
- Much
- Not much
- Not at all

25. What makes you enjoy teaching mathematics?

- It is interesting
- Liked by students
26. What is the general attitude of students you teach towards mathematics?

- Very interested
- Interested
- Fairly interested
- Not interested

27. How do your students take the study of Mathematics?

- Very difficult
- Difficult
- Less difficult
- I do not know

28. How much do you agree with the following statement?
Use only one of the following for each response:-

Strongly agree (SA), agree (A), Undecided (UD), disagree (D) or strongly disagree (SD) for each response.

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>SA</th>
<th>A</th>
<th>UD</th>
<th>D</th>
<th>SD</th>
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<tbody>
<tr>
<td>(a) Students are well in learning mathematics</td>
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<td>(b) KCSE Mathematics is too wide to cover in 4 years.</td>
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<td>(c) Some topics are too hard for students to comprehend.</td>
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<td>(d) The school has textbooks.</td>
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<td>(e) Teachers are well motivated to teach mathematics.</td>
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<td>(f) The students are well guided and counselled on mathematics</td>
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<td>(g) Teachers prefer teaching mathematics in the afternoon</td>
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<td><strong>(h)</strong></td>
<td>The headteacher gives adequate support for the teaching of mathematics.</td>
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<tr>
<td><strong>(i)</strong></td>
<td>Students are not influenced by bad behaviour practices e.g. drugs.</td>
<td></td>
<td></td>
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<tr>
<td><strong>(j)</strong></td>
<td>There is seriousness in learning mathematics in the school.</td>
<td></td>
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APPENDIX II

TEACHER QUESTIONNAIRE

Please use a tick (✓) where appropriate.

1. Age ______  2. Sex: Male □ Female □

3. Qualifications:
   BED □ BSC/BA □
   Diploma □ Other □

4. Teaching Experience
   Over 12 years □ 8 - 11 years □
   3 - 7 years □ 0 - 2 years □

5. What is your workload per week?
   28 periods and above □ 23 - 27 □
   15 - 22 □ Below 15 □

6. Are you teaching other subjects apart from mathematics?
   Yes □ No □

7. What other subjects are you teaching?
   Physics □ Chemistry □
   Geography □ Biology □
8. How many periods in other subjects?
   - 12 periods and above
   - 8 - 11
   - 5 - 7
   - Below 4

9. Do you use teaching aids in teaching mathematics?
   - Yes
   - No.

10. What are some of the teaching aids that you use?
    - Charts
    - Geometry
    - Instruments
    - Models
    - Probability Kit

11. What methods do you use in teaching mathematics? Tick as many as you use.
    - Lecture
    - Problem solving
    - Use of examples
    - Discussion
    - Group work
    - Individual work
    - Discovery
    - Demonstration
    - Programmed learning
    - Questioning technique
    - Field trips
    - Seminars

Other, Specify

Other, Specify
12. How often do you give homework to your students?

Every day [ ] After two days [ ]

After the topic is over [ ] Weekly [ ]

13. After how long do you give the marked homework to students?

The following day [ ] After two days [ ]

After one week [ ] Students exchange notes for marking [ ]

14. How often do you administer tests?

After one week [ ] After two weeks [ ]

After three weeks [ ] After one month [ ]

15. Where do you enter the scores after marking?

Class progress record [ ] Class list [ ]

A prepared book [ ] In an exercise book [ ]

16. Do you have a record as to how your students had scored at KCPE in mathematics?

Yes [ ] No. [ ]

17. Does this grade agree with students progress?

Strongly agree [ ] Agree [ ]

Undecided [ ]

Disagree [ ] Strongly disagree [ ]
18. Why do you think there is a difference between the KCPE grade and the progress record of students?

Methods of teaching [ ] Quality of marking [ ]
Student has relaxed [ ] I have no idea [ ]

19. Do you have sessions to discuss individual performance with weak students?

Yes [ ] No. [ ]

20. How often do you discuss progress?

Quite often [ ] Often [ ]
Occasionally [ ] Not at all [ ]

21. Do you associate mathematics to real life experiences while teaching?

Quite often [ ] Often [ ]
Rarely [ ] Not at all [ ]

22. Do you discuss with your students about job opportunities vis-à-vis the quality of the mathematics grade?

Quite often [ ] Often [ ]
Rarely [ ] Not at all [ ]

23. How much do you like teaching mathematics?

Very much [ ] Much [ ]
Not much [ ] Not at all [ ]

24. What makes you enjoy teaching mathematics?
It is interesting  ☐  Liked by students  ☐
Easy to teach  ☐  Has less preparation  ☐

25. What is the general attitude of students you teach towards mathematics?

Very interested  ☐  Interested  ☐
Fairly interested  ☐  Not interested  ☐

26. How do your students take the study of Mathematics?

Very difficult  ☐  Difficult  ☐
Less difficult  ☐  I do not know  ☐

27. How much do you agree with the following statement?

Use only one of the following: Strongly agree (SA), agree (A), Undecided (UD), disagree (D) or strongly disagree (SD) for each response.

<table>
<thead>
<tr>
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<th>Codes</th>
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<td>SA</td>
</tr>
<tr>
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<td></td>
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<tr>
<td>(c) KCSE Mathematics syllabus is too wide to cover in 4 years.</td>
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<tr>
<td>(d) The school has adequate textbooks.</td>
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<td>(j)</td>
<td>There is seriousness in learning mathematics in the school</td>
</tr>
</tbody>
</table>
APPENDIX III

INTERVIEW GUIDE FOR THE FORM 3 STUDENTS

Answer all the questions

1. Do you like mathematics?

2. If the answer to number 1 is no, state the reason.

3. If the answer to number 1 is yes, state the reason

4. Does the school provide you with mathematics textbooks?

5. Does the school provide you with other mathematics reference books kept in the library?

6. Who buys the textbooks you use in mathematics?

7. How often do you practice some mathematics during your preps in one week?
8. Do you like your teacher?

9. Do you like the way the teacher teaches?

10. Does your mathematics teacher give you assignments often? How often?

11. Does your teacher mark all the assignments in time? Does he/she revise with you after marking?

12. Does your teacher use teaching aids in mathematics? How often?

13. Does your teacher attempt to associate the usefulness of what he teaches per day to real life?

14. Do you practice using the actual KCSE past papers?

15. Does your teacher answer individual difficult questions for you?
16. How often do you do mathematics tests?

17. Do you attend some mathematics public lectures, seminars, or discussions?

18. Are you planning to pursue a course that will involve an excellent grade in mathematics? When?

19. Should mathematics be compulsory? At what level?

20. What in your opinion should be done to make mathematics more interesting and enjoyable?
APPENDIX IV

KCPE MATHEMATICS SYLLABUS TOPICS

1. Whole numbers up to millions
2. Operations on whole numbers
3. Measurements;
   Length, capacity, weight, money, time, area, volume, rates, speed, temperature
4. Geometry
5. Fractions, Decimals, Percentages
6. Algebra
7. Tables and graphs
8. Scale drawing
9. Ratio and proportion

Source: Ministry of Education Syllabus (1992)
APPENDIX V

KCSE MATHEMATICS SYLLABUS TOPICS

1. Numbers
2. Measurement
3. Algebra
4. Geometry
5. Graphs
6. Trigonometry
7. Commercial arithmetic
8. Probability and statistics
9. Vectors
10. Transformations
11. Matrices
12. Navigation
13. Linear programming
14. Area approximations
15. Elementary calculus

Source: Ministry of Education Syllabus (1992)
APPENDIX VI

LIST OF NATIONAL SCHOOLS IN KENYA

1. Alliance Boys High School
2. Alliance Girls High School
4. Garba Tulla High School
5. Kenya High School
6. Lenana School
7. Limuru Girls High School
8. Loreto High School
9. Mangu High School
10. Mary Hill Girls High School
11. Maseno School
12. Moi Forces Academy
13. Moi Forces Academy, Lanet
14. Moi Girls High School, Eldoret
15. Moi High School, Kabarak
16. Nairobi School
17. Nakuru High School
18. Starehe Boys Centre and School