INFLUENCE OF USING SCIENTIFIC CALCULATORS ON SECONDARY SCHOOL STUDENTS' DEVELOPMENT OF COMPUTATIONAL SKILLS IN MATHEMATICS IN MURANG'A COUNTY, KENYA

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OCTOBER, 2016
DECLARATION

I declare that this thesis is my original work and has not been presented in any other university/institution for consideration. This thesis has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited in accordance in line with anti-plagiarism regulations.

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DEDICATION

I dedicate this work to my beloved family, thanks for all your support, love and encouragement.
ACKNOWLEDGEMENT

Many people have contributed to the success of this work and therefore I owe them a lot of gratitude. First, I thank the Almighty God for His guidance and grace that was sufficient throughout my study period.

I express my special gratitude to my supervisors, Dr. Marguerite Miheso O'Connor and Prof. Samson Rosana Ondigi, for their valuable guidance and contribution towards the success of this work. Their interest in my work, commitment and constant encouragement gave me the strength and morale to work harder.

I express my sincere gratitude to all the Principals, Mathematics Heads of Departments and Mathematics teachers of various secondary schools I visited for their co-operation and support during the process of data collection. I also thank the Form three students who participated in answering the questionnaires that were very useful in my study.

While it may not be possible to mention the names of all those who contributed to the success of this work, I acknowledge my sincere gratitude to all of them.
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## LIST OF ABBREVIATIONS AND ACRONYMS

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<th>Description</th>
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<tr>
<td>HOD</td>
<td>Head of Department</td>
</tr>
<tr>
<td>IUA</td>
<td>Irish Universities Association</td>
</tr>
<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>NACOSTI</td>
<td>National Commission of Science, Technology and Innovation</td>
</tr>
<tr>
<td>NCTM</td>
<td>National Council of Teachers of Mathematics</td>
</tr>
<tr>
<td>SCEO</td>
<td>Sub-county Education Officer</td>
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<tr>
<td>TIMSS</td>
<td>Trends in International Mathematics and Science Study</td>
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Abstract
The purpose of the study was to investigate the influence of scientific calculators on mathematical computational skills development among learners in secondary schools in Kandara Sub County, Murang’a County, Kenya. The study was guided by four objectives; (a) to investigate the extent to which scientific calculators are incorporated in teaching and learning of Mathematics in secondary schools in Kandara Sub County, (b) to establish the effect of teachers’ and students’ affective domain towards use of scientific calculators in teaching and learning of mathematics in secondary schools in Kandara Sub County, (c) to determine the extent to which scientific calculators aid in computational skill development among learners in secondary schools in Kandara Sub County, and (d) to investigate the level of influence of scientific calculators on student mathematics performance in Kandara Sub County. The study employed causal-comparative research design. The entire population of Form three students, mathematics teachers and Mathematics Heads of Departments were targeted. A sample of 248 students, 9 Mathematics Heads of Departments and 32 Mathematics teachers were selected using both stratified and simple random sampling. Data was collected through the use of students’ questionnaire, HOD Mathematics Questionnaire and Teacher’s Questionnaire. Analysis of data was done using both descriptive and inferential statistics. In descriptive statistics, frequency tables, means and standard deviations were used to measure teachers’ and students’ attitudes towards Mathematics. Analysis of variance (ANOVA), t-test and Chi-Square ($\chi^2$) were employed for the inferential statistics to determine significance difference of pre-test and post-test scores. It was established that students’ as well as teachers’ attitudes towards Mathematics have greatly improved as a result of scientific calculators. Although the scientific calculators had slightly improved Mathematical performance of learners, they did not support computational skill development of learners. There was no uniform policy on calculator use within the secondary school mathematics education system. Therefore these findings will be useful to policymakers and stakeholders in the education sector as concerns scientific calculator use in teaching and learning of Mathematics in secondary schools in Kenya.
CHAPTER ONE
INTRODUCTION

1.1 Background of the study

The application of technology in Education is considered as a crucial component during the instructional process and its proper and efficient use is known to improve student performance in mathematics. The scientific calculator use in Kenya secondary schools was introduced in 2005 (Muthomi, Mbugua and Githua, 2012). The incorporation of technology and especially scientific calculator in the study of mathematics has become more important in current time. The National Council of Teachers of Mathematics (NCTM) observed that learners' engagement with abstract mathematical knowledge can be enhanced by us of technology (NCTM, 2000). Since technology is considered as a crucial and basic component of the teaching and learning Mathematics, the calculator technology introduction has tremendously influenced the teaching and learning of mathematics (Demana and Waits, 1990). According to Briggs (1977), the incorporation of media during the teaching and learning process propels the learners' attention by seizing and stimulating their interest in the subject.

Even after discovery of electronic calculators more than 40 years ago, calculator technology use has changed enormously from simple calculators to scientific calculators and to the current advanced graphing or graphic calculator technology (Waits and Demana, 2000). NCTM had recommended the use of calculators, more especially graphing calculators, for over twenty years (NCTM, 2002). It was after their recommendation that calculators were entrenched to
enrich students' mathematical abilities beyond their computational levels. They were of the idea that scientific calculator including graphing calculators should be used at all levels of instruction, reporting an increase in conceptual development and number logic. Therefore according to Brumbaugh and Rock, (2001) paper and pencil work should be replaced by technology which works smarter.

According to Porter, (1991) 60% of elementary instructors in California in United States of America used calculators with students, even though the extent of time allocated to calculator use and the level of activities were very limited. Ruthven, (1996) argued that, even after ten years of calculator introduction in mathematics curriculum in the United Kingdom, so many critical issues concerning their utilization in the classrooms remained lowly understood by some Mathematics teachers. A related study by Goos, Galbraith, Renshaw and Geiger in 2000 found a similar context in Austria, that teachers use calculators in a conservative way when these calculators are availed freely into mathematics classrooms. Thus, for efficient application of scientific calculators during learning process, it requires that the subject matter and evaluation criteria should change for effective fulfillment of the intended purpose of scientific calculators (Rosenstein, 2002).

The use of scientific calculators in the Kenya Certificate of Secondary Education (KCSE) was approved in 2005 by the Kenya Ministry of Education for their application in the classroom situation. Scientific calculators are currently allowed as the Mathematics curriculum for solving tedious and lengthy
computations at the secondary school level. Their effective use, accuracy and speed in handling lengthy computations have enabled students and teachers to have access to new opportunities and with renewed approach to Mathematics lessons in a timely and refocused attention. Scientific calculators aid to enhance the application of more cognitive learning approaches in mathematical ideas, some of which requires lengthy calculations, or computations with many digit numbers or decimals. If students use scientific calculators, they can do Mathematical computations in a better way while concentrating and discovering new patterns and making generalizations without getting concerned about computational accuracy. Also, the use of scientific calculator can enable teachers to apply examples from everyday life to set real-life Mathematical problems with real-life figures that are easier for students to solve without the aid of a scientific calculator.

Students thus are able view the relationship between Mathematics and then relate well to the world. With availability of technological devices, students can then concentrate on making judgments, rethinking and problem solving (Noraini, 2004). Technology use broadens the extent and quality of computations by giving out a way of viewing Mathematical concepts from varied angles and direction. Scientific calculators as a technology provide a means of gaining a higher level of Mathematical understanding, rather than losing hope on being tired or bored by tedious and lengthy manipulations and computations for the students. In addition, the scientific calculators use supports the achievement of computational fluency, influence deeper student interest, improve computational
skills of weaker students and thus create more time to be used for development of critical thinking skills. Moreover, the use of scientific calculators does not do away with the need to understand and remember the basic algorithmic concepts and processes of mathematics. Even with the introduction of the scientific calculators in Kenya, student performance in mathematics has still remained poor in the national examinations especially in Kandara Sub County as illustrated in Table 1.1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Candidates</th>
<th>Mean score</th>
<th>Maximum score</th>
</tr>
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<tbody>
<tr>
<td>2009</td>
<td>3750</td>
<td>3.17</td>
<td>12</td>
</tr>
<tr>
<td>2010</td>
<td>3809</td>
<td>3.48</td>
<td>12</td>
</tr>
<tr>
<td>2011</td>
<td>3834</td>
<td>3.21</td>
<td>12</td>
</tr>
<tr>
<td>2012</td>
<td>3723</td>
<td>3.76</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: S.C.E.O Kandara Sub County 2013.

From the table, the mean grade of mathematics has been D plain (D) for Kandara Sub County which is a relatively poor performance. The mean score range has been 3.17 to 3.76 for the year 2009-2012 which is below average. In fact the highest score is 31.3 % (percentage). This is a worrying trend as even with the introduction of scientific calculators, they seem not to contribute positively towards student mathematics performance in Kandara Sub County as the highest
mean score is 3.76. This study thus sought to determine the influence of scientific calculators in mathematical computation skill development in Kandara Sub County, since their introduction has not added positive value to student performance in mathematics.

1.2 Statement of the problem

The scientific calculator increasingly, is becoming a preferred and an accepted way of computing in everyday life activities and business at all levels. Allowing scientific calculators in mathematics curriculum enables students to learn faster and in a more efficient manner while having them attached to what they are learning. More time is made available to students to spend on improving their problem-solving, mental algorithmic and estimation skills by minimizing the emphasis on learning computational arithmetic. This means that more applications can be achieved hence motivating the students who were previously discouraged by long and tedious computations to explore the richness of mathematics.

Despite the fact that Mathematics serves an integral influence in society, the performance in the subject at national examinations has not been satisfying (Aduda, 2003) even after the introduction of scientific calculators. It is not proved if students lack an understanding of the concepts or they do not understand how to use the scientific calculators in solving mathematical problems. It is also not proven if they run short of time due to rigorous repetitive manipulation. This has then raised questions over the probable contribution of these scientific calculators in the learning of Mathematics since the performance
has not improved with their use (Mbugua, Muthomi and Okere, 2011). Therefore
the study endeavored to establish the degree to which scientific calculator
incorporation in teaching mathematics support students’ computational skills
development in secondary schools in Kandara Sub County.

1.3 Purpose of the study

The purpose of the study was to cement the current gap in research in the Kenyan
context by conducting an investigation into the influence of calculator
incorporation on secondary mathematics students. Thus the study investigated the
influence of scientific calculators in mathematical computation skill
development among learners in secondary schools in Kandara Sub County.

1.4 Objectives of the study

The specific objectives of the study were;

i. To determine the extent to which scientific calculators are incorporated in
teaching and learning of mathematics.

ii. To establish the effect of teachers’ and learners’ affective domain towards
use of scientific calculators in teaching and learning of mathematics.

iii. To determine the extent to which scientific calculators aid in
computational skill development among learners.

iv. To investigate the level of influence of scientific calculators on student
mathematics performance.

1.5 Research Hypotheses

i. There is no significant difference among school categories in scientific
calculator incorporation in teaching and learning of Mathematics.
ii. There is no effect of teachers’ and students’ affective domain towards the use of scientific calculators in teaching and learning of Mathematics.

iii. There is no effect in computational skill development among learners due to scientific calculator usage.

iv. There is no influence of scientific calculators on students’ mathematics performance.

1.6 Significance of the study

The findings from this study would be used to inform Kandara Sub County mathematics teachers on effective ways of using scientific calculators as well as the need for effective training of learners on their use in order to improve mathematics computational skills, performance and the implications of scientific calculators’ availability on students’ attitude towards mathematics. The findings of the study will further inform Kenyan secondary school teachers about the relevance of scientific calculators on students’ mathematical performance, and the effects of calculators’ availability on students’ attitudes towards mathematics. The findings will again inform KNEC on the scope in terms of questions to test that require scientific calculator. Also, it will contribute new knowledge to education stakeholders to develop new policies for further exploration of other types of calculators like graphing calculators as well as increasing the relevant research evidence in the Kenyan context.

1.7 Limitation and Delimitation of the study

The following were the limitations and delimitations experienced by this study;
1.7.1 Limitation

The study was conducted in Kandara Sub County which was selected because of its convenience and accessibility. The researcher was limited to time and finance too. If there was enough money and time, the researcher could have conducted the study in the whole county and used a bigger sample size. The findings would have been more generalizable though even the current findings can be generalized. Since a causal-comparative design was used, lack of manipulation, control and randomization are all sources of weakness in a causal-comparative study. That was reduced by the use of control techniques such as analysis of covariance matching and using homogeneous groups.

1.7.2 Delimitation of the study

The study was delimited to assessing secondary school form three (3) students from Kandara Sub-County. This was due to its accessibility to the researcher. For these reason, the generalization of the results of this study is limited. The researcher only looked at the influence of scientific calculators towards mathematics among students in secondary schools in Kandara. Again, in terms of content, the researcher only concentrated on Trigonometry, Logarithms, Squares and Cubes. There are other areas in mathematics that use the scientific calculators. Also, the number of teachers interviewed was not statistically significant and may not have been sufficient to identify all teacher attitudes towards calculator usage. Again the study was limited to only mathematics teachers and heads of department from Kandara Sub County as they are the ones who use the device. It therefore means that the challenges and other attributes
associated to calculator use will only be limited to Kandara Sub County. Therefore the intent of the study is to provide additional evidence on calculator usage and its effect on students’ and teachers’ attitudes and student performance in mathematics as well as provide a basis for further research of calculator use in the classroom setting.

1.8 Assumptions of the study

The following assumptions were made during this study,

i. All the schools that were selected had adequate access to scientific calculators during teaching and learning of mathematics.

ii. All the schools that were selected for this study had qualified teachers.

iii. Learners had knowledge on scientific calculator use during learning of mathematics.

1.9 Theoretical framework

This study was guided the constructivist theory of learning (Bruner, 1973), since constructivist learning has become a prominent theory in teaching during the last decade due to the introduction of new technologies into the classroom, such as computers and calculators. Constructivist theory considers learning as a process of knowledge construction as well as concept development and an in-depth understanding as the main goals of learning (Fosnot, 1996). According to Anderson and Piazza (1996), constructivism is based on two main principles;

i. That knowledge is actively developed by the learner, that is, knowledge is the result of activities as opposed to that of the passive reception of information or instruction. (Anderson and Piazza, 1996).
ii. That knowledge is an adaptive function; i.e gaining new knowledge is a process of adapting to the environment experienced by the learner (Anderson and Piazza, 1996).

In constructivism theory, students are expected to develop conceptual ideas and structures by reflection and abstraction (Glaserfeld, 1995). Constructivists' such as Bruner (1966) and Dewey (1938) state that for learning to occur, the learners must be engaged in the development and reorganization of ideas and concepts. Constructivists believe that learners should be allowed to discover and transform complex ideas and information and that routine teacher-centered processes of pre-determined instruction, knowledge and content is inappropriate (Nicaise and Barnes, 1996). Suggestions by Nicaise and Barnes (1996) also supported that learning by students is enhanced through experience and that when they are allowed to solve problems in situations relating and representing authenticity, they learn more. In the mathematics classroom the constructivist perspective of learning is particularly appropriate since the students construct their own understanding which is seen as being very relevant in building strong computational skills in mathematics (Tajuddin, Tarmizi, Konting and Ali, 2009). Studies have indicated that teachers who frequently use calculators in the teaching and learning of mathematics hold a constructivist teaching philosophy (Becker 2000; Burke, 2001).

A study by Orton (1992) noted that calculators can be used in an exploratory and investigatory way that helps students to develop their own way of understanding of arithmetic. Kissane (1999) defined exploratory data analysis as the checking,
editing, transforming, augmenting, analyzing and re-analyzing of data which has been stored in a calculator. The calculator allows students to investigate different solutions of a mathematical problem (Kissane, 1999). In the constructivist classroom students are not seen as passive absorbers of knowledge but as active participants in their own learning as they obtain new skills through the use of the calculator (Tajuddin, Tarmizi, Konting and Ali, 2009).

Tsao (2006) showed that students who were exposed to a constructivist-based learning approach in a mathematics statistics class gained positive attitudes towards the topic. Research has further shown that constructivist learning environments may offer alternative learning opportunities for those students who do not fully understand mathematical concepts presented in the traditional behaviorist format (Tsao, 2006). This theory is learner centered and is most suitable for this study as it encourages students to be active participants while learning. Scientific calculators are devices that require manipulations and thus students may construct new knowledge while performing these manipulations. Therefore this makes this theory most relevant for this study.

1.10 Conceptual Framework

Figure 1.1 shows the conceptual framework that captures the interrelationship between the independent variable and the dependent variables.
Table 1.1: Conceptual framework on use of scientific calculators

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Intervening Variables</th>
<th>Dependent Variables</th>
</tr>
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<tbody>
<tr>
<td>Influence of scientific calculators</td>
<td>a. Teacher attitude</td>
<td>a. Level of computational skills development</td>
</tr>
<tr>
<td></td>
<td>b. Utilization of calculators</td>
<td>b. Student performance in mathematics</td>
</tr>
<tr>
<td></td>
<td>c. Student preparedness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Student attitude</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1.1: Conceptual framework on use of scientific calculators

The conceptual framework shows the relationships between independent and dependent variables in the study on the influence of scientific calculators in mathematical computation skill development among learners in public secondary schools in Kandara Sub County. The independent variable was the influence of scientific calculators in the teaching and learning of mathematics. This variable had an influence on the dependent variables which are mathematics computational skills, student attitude and student mathematics performance. The intervening variables are; Teacher attitude, student preparedness and utilization of calculators. The independent variable is directly affected by dependent variables while the intervening variables interact with the development of computational skills and student mathematics performance in public secondary schools in Kandara Sub County. The perfect interaction of independent and dependent variables was reflected through attributes of well application of these...
scientific calculators. The indicators include: a highly motivated student body, good condition of these scientific calculators, quality academic performance, accessibility and adequacy of scientific calculators.
1.11 Operational Definition of Terms

The section gives the operational definitions of terminologies used in the study.

**Attitude:** This is taken to mean the teacher/student's acquired internal state or feeling influencing their choice towards teaching and learning.

**Achievement:** Any effect, whether anticipated or unanticipated, positive or negative, brought about by an intervention.

**Behavior:** An individual learner's observable response in a given situation with respect to a given target.

**Mathematics:** The study of the measurement, properties, quantities, sets, shape and space; and their relationships using specialized notations, numbers and symbols.

**Performance:** Refers to the status of students in respect to acquired skills and knowledge as compared to other students or schools, adopted standards or national educational standards.

**Projective technique:** A request to write about a cue figure or to complete a partially formed sentence.

**Scientific calculator:** An electronic device which is used to carry out virtually all mathematical computations.

**Secondary school:** An institution of learning that offers four years of formal schooling based on the four year curriculum which is broad-based and builds on concepts, principles, skills and attitudes established at the primary level.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
The chapter reviews literature that is specific to scientific calculators use in Schools. Review of related literature has been done extensively to cover both local and international research studies. The study therefore sought to investigate the influence of scientific calculators on students' computational skills and performance in mathematics in secondary schools.

2.2 Scientific Calculators and the Learning Process
A calculator is a device for performing both mathematical computations and also for learning mathematics. The scientific calculators have since become crucial devices for mathematical processes and computations (Odera and Ochanda, 2011). The authors also observed that scientific calculators have provided a means for the learners to gain a greater level of understanding mathematics rather than losing hope after being tired or bored by long and time consuming computations. Dunham, (2000) observes that incorporation of calculator results in more positive feelings and better attitudes towards mathematics among learners and teachers. On the other hand, Suydam (1980) noted that, many Mathematics teachers from different countries did not support calculators as being suitable for students because their frequent application weakened the basic concepts of paper-and-pencil skills in computations. If they are incorporated in early stages of life, they may obstruct the learning of number concepts. Dependency on scientific calculators by students, increased chances of students
accepting incorrect answers presented by the calculators and that student will not learn to think if they use the calculators. It is not clear if calculators contribute positively or negatively to the learning process due to the above mixed reactions. Therefore the study sought to investigate the influence of scientific calculators in teaching and learning process in Kandara Sub County since this has not been ascertained.

2.3 Calculators in Teaching and Learning Mathematics

The National Council of Teacher's organization of Mathematics is dedicated to improve mathematics education and thus approved the incorporation of calculators in teaching mathematics (NCTM, 2000). Hembree and Dessart (1986) found out that learners who used a calculator during mathematics instruction had gained a better attitude toward mathematics than who never used calculators. Consistently though research findings have demonstrated that the use of a calculator effectively supports positive attitudes toward mathematics. Despite support for calculator use in mathematics, there are many mathematics educators who doubt that calculators' application may affect negatively students' mathematical ability and result in mathematical illiteracy. There is no empirical evidence on the exact influence of scientific calculators in the teaching and learning of mathematics. This study therefore documents an empirical data analysis on the exact influence of calculators in Mathematics performance in Kandara Sub County, Murang'a County.
2.4 Influence of Calculators on Student’s Attitude

Ellington (2006) reported more positive results in a student’s mathematical achievement and attitude towards mathematics when a student used the calculator for longer periods of time (nine weeks or more). Ellington (2003) stated that;

“To get the greatest benefit from calculator usage within the classroom, calculator use should not be confined to the mere checking of work; it should have a pedagogical influence in the mathematics classroom”(p. 456).

Researchers have shown that students display high enthusiasm and value towards the use of the calculators in mathematics classrooms (Pennington, 1998). Students believe that the calculator improves their ability to tackle Mathematical problems (Dunham and Dick, 1994). Countryman and Wilson (1991) presented a case promoting the usage of calculators within the classrooms which reported that students who used a calculator within the mathematics classroom were engaged and enthusiastic about the basic fundamentals of mathematics.

Kaiser (1994) reported that students displayed enthusiasm for calculators and a greater ability in the mathematics classroom after a few weeks of calculator usage within the mathematics classroom. Gilchrist (1993) also reported that when calculators are permitted in the mathematics classroom, students are more eager to attend mathematics classes. Pomerantz (1997) stated that;

“Learners who may usually be bored with mathematical calculations will no longer feel threatened when confronted with tedious computations when the calculator is present” (p. 3).
This is not a proven fact in Kandara Sub County as there is no empirical evidence on the same. Therefore this study tried to unravel the truth on whether scientific calculators have an influence on students’ attitude towards mathematics.

2.5 Influence of Calculators on Students’ Anxiety

Other researchers have argued that calculators can be used to lessen mathematics anxiety and to counter students’ dislike and phobia for mathematics (Acelajado, 2003; Abador, 2008). The calculator encourages the learning of complex mathematics skills, thereby helping to alleviate issues of mathematics anxiety (Libov, 1985). Many critics of calculator use are of the belief that calculators function as a crutch for many students. The crutch premise is manifested from the opinion that learners may become over-reliant on the calculators to the detriment of their mathematical understanding (Carter, Ferrucci and Yeap, 2008). In 1976, Suydam questioned this crutch premise. Suydam (1976) argues that the crutch premise rests on the principle that a crutch is a bad thing and that to an injured person a crutch is often a necessity in some cases. Suydam (1976) also noted that for the students, the non-use of the calculator would condemn them to a life without arithmetic.

Suydam (1976) concluded that for such students the calculator is not a crutch but their only way of accessing the correct answer. Suydam (1976) further advised that once the basic computational skills had been learnt, the use of the calculator in a mathematics classroom did not harm students’ calculation skills. Suydam (1982) reported that there was no evidence that students become
calculator dependent. This study therefore found out if calculators really have an influence on students' anxiety towards mathematics in Kandara Sub County.

2.6 Calculators and Students' Confidence

Another prominent concern surrounding calculator usage is the notion that calculators give students an overrated sense of confidence concerning their genuine mathematical computation ability (Burke, 2001; McCauliff, 2004). Linn (2000) found that too much of mathematics instruction is spent teaching students how to use a calculator instead of teaching mathematics computation and problem solving skills. Hunsaker (1997) found that calculators use result in student with skills of manipulating numbers mentally and they become better equipped to handle mathematical problems and computations. These students will also have a better idea as to what the answer to a problem should be, as experience has taught them a degree of number sense. Moreover, Hunsaker (1997) stated that;

“Students, who erroneously enter a problem into the calculator without noticing, do not question the answer as students believe that the calculator is always right” (p. 21).

Most importantly, Hunsaker (1997) argued that the purpose of teaching mathematics is for thinking and discipline, all of which the calculator does not facilitate. It had not been established whether calculators affects students' confidence in Kandara Sub County and thus the study investigated this.

2.7 Scientific Calculators and Skills Development

Technology accessibility by each learner lies partly on the proposition that getting correct answers is not the essential part of the mathematics curriculum,
(Zheng, 2008). Students should interact with activities that are meaningful for them to develop originality and acquire creativity. However, there are concerns that if technology is used frequently in mathematics, then students will not have a chance to develop their skills as the device will be doing most of the work. When difficult problems are solved instantly, the underlying concepts are often masked and become invisible to users. The effectiveness of getting correct answers from a calculator may conceal a lack of understanding to the Mathematical content (Zheng, 2008).

Even though calculators create new teach-ability and learn-ability, the way it solves Mathematical problem is usually numerical in nature. For that matter, the students who may not have acquired the necessary problem solving skills, calculators give them a feeling of relieve. Calculator usage also enhances the procedural inclination of an arithmetic problem for such students who never successfully developed structurally during learning of mathematical computations (Zheng, 2008). There is no study that has been done to investigate if scientific calculators aid in skill development in mathematical computations. Therefore this study looked at the influence of scientific calculators in mathematical skill development.

2.8 Effects of Calculators use on Computational Skills

Critics believe that calculators use within the mathematics classroom may impede learning. The main fear cited by critics is that calculator use within the mathematics classroom may interfere with the mastery of basic arithmetic computational knowledge gained through the routine paper-and-pencil processes
(NCTM, 1974). Hembree and Dessart (1992) argued that sustained calculator use by students hampered students’ basic paper-and-pencil skills. Other opponents against the application of scientific calculators in the mathematics classroom have cited that students will become over-reliant or dependent on the calculating device the risk being that the calculator will serve as a crutch for support to students. The crutch premise essentially means that if students use the calculator for simple mathematical computations that can be done without the calculator, the students will be unable to do these simple computations when the calculator is taken away. Lingefjard in 2006 questioned the use of calculators within the mathematics classroom (Persson, 2008). They argued that the frequent and regular use of calculators at secondary school level could lead to a decrease in manual and mental skills of students (Persson, 2008). McCauliff, (2004) argues that if students become reliant on the use of the calculator, if only for the checking of answers, they will suffer when the calculator is absent and thus make them lazy (Surgenor, Oldham, Close, Shiel, Dooley and O’Leary, 2007). There is no study that has been conducted in Kandara Sub County to confirm if calculators have any effect on mathematical computational skill among learners. Therefore the study looked at the effect of scientific calculators on mathematical computational skills among learners.

2.9 Problem Solving Behavior and Calculator Use

Zheng (2008) further argues that student’s problem solving behavior changes as students desperately look up for answers using their scientific calculators during mathematics evaluation even for the problems that have nothing to do with a
calculator. While doing that, they misunderstand a problem and give up efforts to look up for other solution paths thereby fail to understand a problem solving process (Polya, 1957). Their problem solving skills become weakened and then they are left with the calculator as their main tact for trial and error. For this kind of students, the scientific calculator serves as a crutch for support and this can make them to become over reliant on calculator technology. With the quick advancement in technology and its enormous influence on various disciplines, Steen (1993) defined mathematics as “a science of patterns”. According to this view, mathematics discipline should be studied similar to how science is done, i.e. systematic attempts, based on observational study, and experimentation, to determine the nature or principles of regularities in systems (Schoenfeld, 1992). Despite all these, no study has been carried out to establish whether the high frequency use of calculators leads to problem solving behavior change in mathematics and therefore this study investigated that.

2.10 Calculator use and Students’ Time Management

Proponents for calculators' usage within mathematics classrooms believe that through calculators use, learners will become more comfortable in handling new and emerging technologies (Linnand Slotta, 2000). In a survey conducted to identify commonly used mathematical skills used in occupations, it was identified that 98% of respondents used the calculator in their jobs (Saunders, 1998). Therefore, it could be argued that if the calculator is so readily required in the real world then it seems prudent that learners get the opportunity to apply this learning tool in classrooms. Other researchers looked at the technological
advantage presented by the calculator; its ability to reduce the time spent on mathematical computations leading to increased amount of time spent on learning and understanding mathematical concepts, discovering and observed patterns (Pomerantz, 1997). Pomerantz (1997) opines that there is very little mathematical reasoning involved when performing mathematical computations, therefore learners do not miss out on anything while using calculators to do the computations. This had not been established in Kandara Sub County and thus the study established if calculator use really aided in students’ time management while performing mathematical computations.

2.11 Influence of Calculators on Student’s Performance

Research has shown that there can be many positive effects from calculator usage in the Mathematics classroom. The definitive study on the effects of calculator usage on mathematics achievement by Hembree and Dessart (1986) concluded that from-conjunction with traditional mathematics can improve paper-and-pencil skills, in basic calculations and solving skills of problems. Hembree and Dessart (1986) stated that;

“Learners with calculators acquire better attitude towards mathematics with a relatively better self-concept in mathematics than non-calculator use students” (p.17).

In the 1992 NCTM Yearbook edited by James Fey and Christian Hirsch, Hembree and Dessart further argued that an appropriate usage of the calculator in the mathematics classroom improves paper-and-pencil skills for low, average, and high ability learners (Dunham, 2000).
In another meta-analysis of twenty-four studies done between 1984 and 1995, Smith (1997) as part of a Doctoral dissertation for Texas University-Commerce extended the results found by Hembree and Dessart. Smith (1997) reported significantly higher performance for students who used the calculator; and found out that calculators use had a significant positive effect on students in problem solving, computation, and conceptual understanding.

Smith (1997) also reported that development of paper-and-pencil skills were not compromised by use of calculators. Another meta-analysis of fifty-four studies to determine the attitude levels and implications of calculators on learners' achievement in Mathematics by Ellington (2003) found that calculator usage during instruction testing, students maintained paper-and-pencil skills experienced an improvement in Mathematical operations and the skills required for understanding computations. The study was geared towards confirming if this was true among learners in public secondary schools in Kandara Sub County.

2.12 Calculators and Student's Mathematical Achievement

Reynolds and Farrell (1996) suggested in their review of international surveys of educational achievement that one of the reasons for a low mathematical achievement by students in England was due to an early incorporation of calculators into the mathematics classroom and their frequent use (Keys, 1999). In 1999, the TIMSS report observed that three out of the top five scoring countries in Mathematics (Belgium, Korea, and Japan) never or occasionally used a calculator in the mathematics classroom (Beaton, Mullis, Martin, ...
Gonzalez, Kelly, and Smith, 1996). In contrast, ten of the eleven countries (including the United States) who scored lower than the international average reported using a calculator daily or several days in a week in the mathematics classroom (Beaton et al., 1996). Findings from the TIMSS 1999 report further suggests that students who have limited or virtually no access to a calculator in the mathematics classroom can obtain higher test scores than a group of students who routinely use a calculator in a mathematics classroom.

Antonijevi (2005) argued that students with no calculator access in the mathematics classroom must master all the knowledge and skills required in computation and they consequently attain better test scores in mathematics. Papanastasiou and Paparistodemou (2002) examined the interrelationships that exist between calculator usage and mathematics achievement using the 2003 TIMSS data set. The sample of this study included eight grade students from the United States, Cyprus, the Russian Federation, and South Africa. Papanastasiou and Paparistodemou (2002) concluded that calculator usage did not have any practically significant effect in the Russian Federation and in South Africa whereas calculator usage was negatively associated with mathematics achievement in Cyprus and positively associated with Mathematics achievement in the United States. Again these results further suggest that calculator usage in the classroom may not increase the students’ performance in mathematics. All this has not been established whether it was true or not in Kandara Sub County and thus the study sought to establish whether there existed a relationship between calculator use and student’s mathematical achievement.
2.13 Summary of Existing Gaps in the Reviewed Literature

In concluding of the literature reviewed, the researcher observed several gaps that rationalized the study. The current study therefore sought to fill the gaps which include documenting on whether calculators really aid students' mathematical computation skill development, the extent of scientific calculator incorporation in teaching and learning of mathematics, attitude change among learners and teachers due incorporation of scientific calculator in the teaching and learning of mathematics and challenges experienced during the teaching and learning while using scientific calculators in Kandara sub county public schools.
CHAPTE THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology framework that was applied in collecting, analyzing and interpreting the research data needed to achieve the objectives and aims of the study. Aspects discussed include; research design, variables, locale of the study, targeted population, sampling procedure, sampled size, research instruments, pilot data collection, data analysis and legal and ethical considerations.

3.2 Research Design

This study employed a causal-comparative research design. A causal-comparative research design is a non-experimental method that provides better evidence of cause and effect relationship (Kiplagat P., Role E. and Mukewa A., 2012). According to Gay (2006), causal-comparative research design determines reasons or cause for the current status of the phenomena under study. In this study, causal comparative research-design was used to determine the influence of scientific calculators on students’ mathematical computation skill development. This was achieved by employing a pre/post-tests where students of both gender were selected from different school categories. Students’ opinions on how the incorporation of scientific calculators influenced their computation skills were also sought. Both quantitative and qualitative techniques were used in collecting and analyzing data. A quantitative research approach explains
phenomena through collection of numerical data which are then analyzed by use of mathematical methods. Neville, (2005) opines that:

"Numerical results are structured and highly detailed and can be easily gathered and statistically presented"(p. 3).

Qualitative researches involve first-hand accounts of experiences which aim to describe events in detail, (Terr and Kelly, 1999). Denzin and Lincoln (1994) argued that;

"A qualitative research approach aims to interpret or make sense out of phenomena in terms of the meanings people bring to them"(p. 183).

This study generated qualitative data through an interview with selected Mathematics teachers of secondary schools who had direct experience and knowledge of the various aspects of calculator usage during classroom instruction. The use of both quantitative and qualitative methods established rich sources of data through the drawing of measurable data covering all aspects of this study.

3.3 Variables of the Study

A variable is a quantitative or qualitative entity which can take on different values or levels (Npka 1997). The variables in this study include the independent variable (influence of scientific calculators), dependent variables (student mathematics performance, student attitude and computational skill development) and intervening variables (teacher attitude, utilization of calculators and student preparedness).
3.4 Location of the Study

The study was done in Kandara Sub County in Murang’a County, Kenya. The research area was chosen because of the researcher’s recognizability with it which assisted improve the management of the study process. This was guided by Gay’s (1996) argument that factors like familiarity with an area, time limitations and available resources may influence a researcher’s selection of locale. It was an ideal location for the researcher due to its accessibility and this eased the process of data collection. Kandara Sub County has 50 public secondary schools.

3.5 Target Population

Target population is a detailed account of all items in the population as used in the study. Thus, it is the population to which the researcher will intend to generalize the findings (Nkpa 1997). The target population for this study was all public secondary schools (50) in Kandara Sub County. The researcher targeted all Mathematics teachers (390) and 3480 Form three students in all the schools and all mathematics head of departments (50) in Kandara Sub County.

3.6 Sampling Procedure and Sample Size

Sampling is the procedure a researcher will use to identify people, places or subjects of study. It is a process of selecting individuals or objects from a target population whereby the selected groups contain elements representing the characteristics contained in the entire group (Orodho and Kombo, 2002).
3.6.1 Sampling Procedure

The study employed stratified sampling, purposeful sampling and simple random sampling techniques. Stratified sampling was used to pick schools from the three divisions into which the study area was clustered. In stratified random sampling, the population is divided into two or more groups using a given criterion and then a given number of cases are randomly selected from each population sub group (Mugenda and Mugenda, 2003). The obvious advantage in stratified random sampling was that it ensures inclusion, within the sample of sub group, which otherwise would have been omitted entirely during sampling due to their small numbers within a population (Mugenda and Mugenda, 2003). Schools from each division were categorized as mixed day and boarding and boys or girls schools. Purposeful sampling was then used to pick schools from the divisions. This was adopted because there were four categories of schools against three divisions and also due to unequal number of the school categories. Simple random sampling was then used in picking the students for the study. This was done by randomly picking pieces of paper with names of the students that were placed in a container. The researcher also gathered information from mathematics teachers of the schools that were involved in the study. Upon selecting the nine schools, the researcher used form three students for the study because they were better placed, had longer experience with scientific calculators.

3.6.2 Sample Size

The sample size is the sampled population for the study. A sample is finite part of a statistical population where properties are studied to gain information about
the whole (Webster, 1985). The researcher targeted 348 (10%) of the students from the sampled schools but worked with 248. This was because some of the students were not available due to school fees related issues in three of the sampled schools. As for teachers who participated in the study, the researcher targeted 39 (10%) but worked with 32 mathematics teachers who were available and 9 mathematics heads of departments (Table 3.1).

**Table 3.1: Sampling grid**

<table>
<thead>
<tr>
<th>School category</th>
<th>Enrolment</th>
<th>No. of sampled students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed boarding</td>
<td>School A = 120</td>
<td>12 (10%)</td>
</tr>
<tr>
<td></td>
<td>School B = 300</td>
<td>30 (10%)</td>
</tr>
<tr>
<td></td>
<td>School C = 490</td>
<td>49 (10%)</td>
</tr>
<tr>
<td>Mixed day</td>
<td>School A = 140</td>
<td>14 (10%)</td>
</tr>
<tr>
<td></td>
<td>School B = 190</td>
<td>19 (10%)</td>
</tr>
<tr>
<td></td>
<td>School C = 160</td>
<td>16 (10%)</td>
</tr>
<tr>
<td>Boys boarding</td>
<td>School A = 430</td>
<td>43 (10%)</td>
</tr>
<tr>
<td></td>
<td>School B = 350</td>
<td>35 (10%)</td>
</tr>
<tr>
<td>Girls boarding</td>
<td>School A = 300</td>
<td>30 (10%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2480</td>
<td>248 (10%)</td>
</tr>
</tbody>
</table>

Source: Primary data 2015

### 3.7 Research Instruments

A number of research instruments that were employed to aid in the data collection: a questionnaire, a pre-test, a post-test, observation and an interview schedule.
3.7.1 Students' and teachers' Questionnaires

Questionnaires have the ability to generate data from a large sample relatively inexpensively and are the most efficient way of collecting research data without placing pressure on its participants (Thietart, 1999). The study used a designed questionnaire to assess student’s attitudes toward the subject of mathematics and calculator use (Appendix 1). All items were closed-ended statements that asked each student to rate as either; Strongly Agree (SA); Agree (A), Disagree (D), or Strongly Disagree (SD), (Appendix 1). Closed-ended statements were chosen as participants were able to rate them with minimal effort and answers are easy to analyze. Furthermore, given the age profile of the intended questionnaire recipients the use of open-ended questions was deemed to be inappropriate.

3.7.2 Projective Technique

The pre-test/post-test assessment is widely used, and is accepted as a reliable measure of outcome assessment across many disciplines (Adams, 1995). Both pre-test/post-test instruments were used to assess the scientific calculator’s influence in the mathematical performance of students (Appendix II). The instrument generated rich and valuable data to assess the calculator’s influence in the student’s mathematical performance. The pre-test/post-test data can show a variation in test scores that can be measured for significance. During pre-test/post-test instrument administration, students were introduced to the study then they participated in a 30 minute pre-test without access to calculator and then participated in a 30 minute post-test with a calculator.
3.7.3 Interview Schedule

Bell (2005) argues that an interview is an efficient way of gathering research data, where the interviewer probes for responses from the interviewee and examines their attitudes and motives toward the subject. Interviews are one of the best ways of generating both personal and detailed in-depth information (Walonick, 1996). The interview instrument (Appendix IV) was employed to gather data from the mathematics teachers of selected secondary schools in Kandara Sub County.

3.7.4 Observation Schedule

Mugenda and Mugenda (2003) opine that an observation schedule records observations by the researcher during data collection. Orodho (2003) also argued that observation schedule helps to collect data in things or occurrences as they occur naturally. In this study, the researcher prepared observation schedules containing statements on scientific calculators’ usage in the teaching and learning process in secondary schools.

3.8 Piloting

Piloting is trying out of research instruments on the respondents who will not be used in the main study. Gall, Borg and Gall (1996) noted that a pilot study is necessary because a researcher embarking on classroom research for the first time will find it valuable to spend some time in the classroom using one or more established systems and looking at the kind of issues which will arise in turning his/ her own research questions into a set of criteria and definition for use in the classroom.
Therefore it was necessary to pre-test the instruments of the research on a small sample of respondents in a preparatory exercise to find out if there any weakness so that it could be corrected. The questionnaires and the pre/post tests were pre-tested to a sample which was representative and similar to but not the actual sample which the researcher used in the study guided by procedures that were subsequently employed during the actual data collection. In this study, two schools that did not take part in the main study were selected for piloting: A sample of 20 Form three (3) students, 4 mathematics teachers and 2 H.O.Ds were used for piloting. The schools were one boys’ boarding secondary and one day secondary school. The items in those instruments found with unclear and distorted meanings were rectified; however the students were subjected to similar features to the schools that were used for the final study.

3.8.1 Validity of the Instruments

The issue of validity is assessed in terms of what is a credible explanation to fact or truth (Silverman, 2000). Validity therefore is the extent to which a research instrument is able to measure its intended measurement and by presenting the right questions framed appropriately. Therefore for a research instrument to be valid, the selected content in the questionnaire and interview must be relevant to the variable being studied. For this study, validity referred to content validity which also reflects the extent to which differences contained within a measuring instrument reflects a true difference among those being investigated (Kothari 2006). Mugenda and Mugenda (2003) also refers content validity as a measure of the degree to which data collected using a research instrument presents a
specific content of a concept while construct validity measures the degree to which data obtained from a research instrument accurately reflects a theoretical framework.

In order to test for the validity of the questionnaire and the interview schedule, they were examined by two supervisors for verification. These instruments were then piloted in two public secondary schools known to the researcher; but did not take part of the study and were selected for purposes of testing validity. Based on the outcomes and suggestions made by the supervisors and respondents, the researcher modified the content of the questionnaire and interview questions. The modifications included adjustment of irrelevant questions and the revision of questions.

3.8.2 Reliability of the Instruments

According to Bell (2005), reliability is the extent to which a test or procedure produces similar results under comparable conditions on all occasions. Robson (2002) noted that there are four threats to reliability that should be avoided; participant error, participant bias, observer error and observer bias. Therefore, in order to reduce these threats, the students were prepared by explaining the aims and objectives of the study and gave the students constant reassurance regarding their anonymity. This assisted in reducing participant error and bias (Zikmund, 2000). The researcher endeavored not to show personal bias by avoiding certain gestures or comments during interviews so as to avoid influencing the interviewees and piloting was also done to ensure that the researcher came up with well-polished instruments by rectifying any inconsistencies noticed during
the pretest. A spearman rank correlation coefficient was used to determine reliability of the instruments where a correlation coefficient of more than 0.5 was considered rationale for the instruments to be used for data collection.

3.9 Data Collection Procedures

The researcher obtained permission from the government agency authorizing research to be carried out. The researcher visited the sampled schools to familiarize and seek permission from the school heads and principals then organized with Mathematics teachers of the randomly sampled form three (3) students and H.O.D’s to arrange an appropriate time to give out the questionnaires and pre-test and post-test. Data was then collected as described below.

3.9.1 Teachers’ Heads of Department and Questionnaire

The researcher obtained permission from principals of the selected schools to administer the questionnaires. The researcher explained to the teachers the purpose of the research and established a rapport and reassured them of confidentiality. The questionnaires were administered at an agreed time and then collected for analysis.

3.9.2 Students’ Questionnaire and Tests

The researcher obtained permission from the school administration then the researcher discussed with Mathematics teachers of the chosen classes on the day and time to administer the questionnaire and test. The researcher met the students on the agreed day and time and explained the purpose of the study and explained the items on the questionnaire and tests and let the students to fill the
questionnaires and tests. The questionnaires were then collected after the students had finished filling and the procedure was followed in each of the nine (9) schools selected for the study.

3.9.3 Interview Schedule

The researcher obtained permission from the school principals of the 9 selected schools on the time to administer the interview scheduled. The researcher agreed with the principals and head of Mathematics department on the convenient time for the interview schedules to be collected. The researcher then administered the interview schedules as agreed with the above respondents.

3.10 Data Analysis

Both descriptive and inferential statistics were used to analyze the collected data. To investigate the extent to which scientific calculators were incorporated in the teaching and learning of Mathematics in secondary schools, descriptive statistics, frequencies, means, standard deviation and percentages were used to analyze the teachers’ frequency of use of scientific calculators while teaching Mathematics, students’ opinions on the use of calculator and frequency of use while solving Mathematical problems and their preparedness to use scientific calculators while solving problems. To establish the effect of learners’ attitude towards use of scientific calculators in teaching and learning of mathematics, a t-test was performed to determine the significance of students’ attitudes towards scientific calculators by gender while chi-square was used to determine the relationship between students’ gender and their attitudes and ANOVA was used.
to determine significant mean differences of students' attitudes by school category.

To determine the extent to which scientific calculators aid in computational skill development among learners, analysis of variance (ANOVA) was used to determine the statistical significance between pre-test and post-test mean scores at alpha, $\alpha = 0.05$ level of significance. The quantitative data was collected through questionnaires for the students, teachers and head of departments which were then processed by coding the closed ended questions and entering the data into the SPSS programme to conduct a descriptive and inferential analysis. For the open ended questions from questionnaires and interview schedules from Mathematics heads of departments, the data was categorized and themes established, coded and analyzed descriptively. The researcher reported and discussed the findings using charts and tables. The summary, conclusion and recommendations were presented in chapter 4 and 5.

3.11 Legal and Ethical Considerations

All study participants were briefed about the content and intended purpose of the study prior to all data collection techniques being initiated. Permission was sought from principals and teachers to use the data collected to aid in the fulfillment of the research goals. Student participants were free to withdraw from the study without providing reasons throughout the research exercise since participation was voluntary. Students were assured of confidentiality and no identification was done. The researcher avoided embarrassing questions which will interfere with self-esteem of the respondents as Gay (1996) opined. A
research permit was sought from the National Commission of Science, Technology and Innovation (NACOSTI) and an authorization letter from Kenyatta University graduate school board and County director of Education Murang'a county before commence of the study.
CHAPTER FOUR
DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

Data analysis involved examining what was collected in the causal-comparative and further made deductions and inferences. It involved drawing out relevant study variables, anomaly detection and testing for any underlying assumptions. It also involved scrutinizing the generated information and providing appropriate inferences as reported by Orodho and Kombo (2002).

The study investigated the influence of scientific calculators in mathematical computation skill development among learners in public secondary schools. Data collected was analyzed to get the overall picture of students' attitude towards scientific calculators. Specifically data was analyzed to:

i. To investigate the extent to which scientific calculators are incorporated in teaching and learning of mathematics.

ii. To establish the effect of teachers' and learners' affective domain towards use of scientific calculators in teaching and learning of mathematics.

iii. To determine the extent to which scientific calculators aid in computational skill development among learners.

v. To investigate the level of influence of scientific calculators on student mathematics performance.

The main research instruments were; students' questionnaire, teachers' questionnaire, HOD mathematics questionnaire, a pre-test, post-test and
interview schedule. Four research hypotheses were tested. The independent variable, influence of scientific calculators was considered against students’ and teachers’ attitudes, student preparedness, student performance in mathematics and utilization of calculators. Both descriptive and inferential statistics were used to analyze the data. For descriptive statistics, frequencies, means, standard deviation and percentages were used while for inferential statistics, paired t-test, the analysis for variance (ANOVA) and chi-square ($\chi^2$) were used to test the hypotheses at alpha, $\alpha = 0.05$ level of significance and appropriate degrees of freedom.

4.2 Biographical Data of the Respondents

This section presents biographical data of the respondents who were drawn from students, mathematics teachers and heads of departments. A total of 248 students participated in the study from the sampled schools. Teachers were asked about their gender, age, academic and professional qualifications, teaching experience and the classes of teaching. Available teachers from the sampled schools who participated in the study were both male (24) and female (8).

4.3 Extent of Scientific Calculator use in Learning of Mathematics

Objective one of this study was to investigate the extent to which scientific calculators are incorporated in the teaching and learning of Mathematics in secondary schools. A questionnaire investigating the extent to which scientific calculators are incorporated in the teaching and learning of Mathematics was administered to thirty two (32) Mathematics teachers and 248 form three (3) students in the sampled schools. Teachers and students were asked about their
opinion on the use of scientific calculators and their responses were analyzed as shown in Table 4.1.

Table 4.1: Teachers always use scientific calculators while teaching

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>No</td>
<td>24</td>
<td>75</td>
</tr>
</tbody>
</table>

Teachers were asked whether they always used scientific calculators while teaching Mathematics and 75% of the teachers agreed that they do not always use a calculator while teaching Mathematics and that these scientific calculators have not affected the amount of effort they put in teaching Mathematics. This implies that learners do not get sufficient knowledge and guidance in the use the scientific calculators when learning Mathematics since it is a small percentage of teachers that always use. However, there is considerable support in the literature review that when used appropriately, calculators enhance students learning of mathematics (Ellington, 2003). The students were also asked their opinion on whether there were adequate scientific calculators in the class; whether their scientific calculators were always in good and working condition and whether they sometimes shared calculators with other classmates. Table 4.2 analyzes students' opinion.

Table 4.2: Students' opinion towards use of scientific calculators

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A),
Strongly Agree (SA)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are adequate calculators in the class</td>
<td>SD 46%  D 34%  U 6%  A 8%  SA 6%</td>
</tr>
<tr>
<td>The calculator is in good and working condition</td>
<td>SD 41%  D 37%  U 4%  A 6%  SA 12%</td>
</tr>
<tr>
<td>I sometimes share my calculator with my classmates</td>
<td>SD 6%  D 11%  U 10%  A 39%  SA 34%</td>
</tr>
<tr>
<td>Mathematics teacher encourage us to use calculators every time when doing a math problem</td>
<td>SD 8%  D 10%  U 2%  A 32%  SA 48%</td>
</tr>
<tr>
<td>Mathematics teachers always use calculators while teaching</td>
<td>SD 10%  D 24%  U 1%  A 27%  SA 38%</td>
</tr>
<tr>
<td>Mathematics teachers adequately guides us in the use of calculators</td>
<td>SD 52%  D 33%  U 3%  A 7%  SA 5%</td>
</tr>
</tbody>
</table>

The results in Table 4.2 indicate that the majority (46%) of the students strongly disagree that there are adequate scientific calculators in classrooms and that the available scientific calculators are in good working condition with 41% of them strongly disagreeing. This implies that the calculators are therefore not available to all students and not all available calculators are in good working condition. This made some of the students not accessing good working scientific calculators when learning Mathematics. That being a situation where students would miss
services of a calculator, yet it is an essential requirement in some of the areas of Mathematical computation, leaving learners with the only option of borrowing from others in a Mathematics classroom. This could be one of the attributes why performance in Mathematics has been affected as opined by Ochanda and Indoshi (2011) that;

“Availability of this resource determines whether a learner will be able to use it effectively in computations or not” (p. 109).

Since the scientific calculator is an important learning device, it should be accessible to students and should always be in good working condition before using it when doing Mathematical computations as well as during examinations. The students also agreed (48%) that Mathematics teachers encourage them to use scientific calculators every time when solving mathematics problems but disagreed (52%) that Mathematics teachers, adequately guides them in the use of scientific calculators. This was attributed to teachers not providing enough guidance to students on how to use scientific calculators early enough, before mathematical concepts from particular topics are taught as Ochanda and Indoshi found out in 2011. This problem was associated with the teachers’ low level of preparedness which agrees with a study conducted by Kituku (2004) on lesson planning by teachers in secondary schools. The study revealed that, lack of teacher preparedness leads to ineffective content delivery, which may in turn leads to ineffective learning process. The researcher sought to find out whether the students had sufficient scientific calculators in the classrooms and how frequent they used them in calculations and examinations as presented in Figure 4.1.
4.4 Challenges in the use of scientific calculators

The study also sought to identify any challenges experienced during teaching and learning of Mathematics as a result of using scientific calculators. The teachers' views and challenges towards the use of scientific calculators were assessed using a semi-structured interview format where each teacher participant was given a consent form that explained the study.
4.4.1 Challenges in scientific calculators

Seven variables were extracted from the interview data; Whether teachers always used a calculator while teaching Mathematics, whether there was a difference in performance of students who regularly uses calculators from those who does not, whether calculators enables teachers to complete the syllabus on time, whether students with calculators only gave answers without showing working methods, Whether the use of a calculator makes students over reliant on them, whether calculators make students improve on time management when solving problems, Whether calculators increases student’s confidence and reduces anxiety while solving Mathematical problems, whether students prefer paper and pencil even with access to calculators and whether there exists a clear policy for calculators use in the secondary school. Table 4.3 provides a breakdown on teachers’ views and challenges towards the use of scientific calculator in secondary schools.

Table 4.3: Teachers’ views on challenges in use of scientific calculators

Key: SA-Strongly Agree, A- Agree, D- Disagree, SD-Strongly Disagree

<table>
<thead>
<tr>
<th>Statement</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always use a calculator while teaching Mathematics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD: 28.1%</td>
</tr>
<tr>
<td>There is a difference in performance of students who use a calculator from those who do not</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD: 3.12%</td>
</tr>
<tr>
<td>Calculators enables completion of syllabus in time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD: 31.2%</td>
</tr>
<tr>
<td>Students with calculators only give answers without showing methods</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD: 21.8%</td>
</tr>
<tr>
<td>Statement</td>
<td>62.9%</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Use of a calculator makes students over reliant on them</td>
<td></td>
</tr>
<tr>
<td>Calculators make me improve time management in solving problems</td>
<td>21.8%</td>
</tr>
<tr>
<td>Calculators increases student's confidence and reduces anxiety</td>
<td>21.8%</td>
</tr>
<tr>
<td>Students prefer paper and pencil even with access to calculators</td>
<td>18.7%</td>
</tr>
<tr>
<td>There is a clear policy for calculator use in the school</td>
<td>43.8%</td>
</tr>
</tbody>
</table>

A high number of teachers 12% noted that they do not always use a calculator while teaching Mathematics yet 46% of the teachers also agreed that scientific calculators improves performance of students in Mathematics. This will imply that not all students get enough training on use of scientific calculators even though majority of teachers agree that calculators improve students’ performance which supporting Ochanda and Indoshi (2011) that that learners lack hands-on training opportunities on calculators usage in Mathematics because teachers do not adequately guide students on how to use these scientific calculators. Majority of teachers 37% agreed that Calculators enables completion of syllabus on time while 46% of them strongly agreed that most students with scientific calculators only provide answers without showing working methods while doing Mathematical tests. This implies that scientific calculators enable teachers and students improve on time management but students fail in computational skills development.

A half (50%) of the teachers agreed that most students prefer paper and pencil even with access to calculators disagreeing with findings of Hunsaker (1997) that students do not question an answer presented by the calculator as they
believe that the calculator is always right which disagrees with McCauliff (2004) who noted that students become over-reliant or dependent on the scientific calculator with the risk of the calculator serving as a “crutch” for the students. This implies that teachers believe that scientific calculators do not contribute to Mathematical skill development by learners which disagrees with Orton (1992) who recommended calculator use to help students construct their own understanding of arithmetic. It could also indicate a low proficiency in the use of scientific calculators which supports findings from Ellington (2003) that students maintained paper-and-pencil skills during instruction and testing when the calculator was available. Therefore the study findings on determining the challenges experienced by teachers and students in the use of scientific calculators suggest that some 12% of the teachers do not use a calculator while teaching Mathematics yet 46% of them accept that scientific calculators improve performance of students in Mathematics. Although 37% of the teachers agreed that calculators enables completion of syllabus on time, 46% of them strongly agreed that most students with scientific calculators provide answers only without showing working methods while doing Mathematical tests. A half (50%) of the teachers was of the opinion that most students prefer paper and pencil even with access to calculators which remains as a challenge.

4.5 Scientific Calculator usage and Teachers’ Attitude

Objective two of the study was to investigate the effect of teachers’ and learners’ affective domain to the use of scientific calculators in teaching and learning of Mathematics. This was necessary because attitudes (which fall in the affective
domain) towards calculators play an important role on the teaching and learning process of mathematics as well as affect students’ achievement in mathematics. A questionnaire investigating the effect of teachers’ attitudes towards scientific calculators was administered to thirty two (32) Mathematics teachers in the sampled schools. Teachers were required to give their opinions on the use of scientific calculators and their responses were analyzed as shown in table 4.4 below.

Table 4.4: Teachers’ attitude towards scientific calculator use

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>U</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of a calculator can improve teacher’s attitudes</td>
<td>6%</td>
<td>10</td>
<td>3%</td>
<td>25</td>
<td>56</td>
</tr>
<tr>
<td>Students enjoy solving problems with calculators</td>
<td>0%</td>
<td>3%</td>
<td>5%</td>
<td>41</td>
<td>51</td>
</tr>
<tr>
<td>Calculators make students lazy</td>
<td>0%</td>
<td>8%</td>
<td>4%</td>
<td>35</td>
<td>53</td>
</tr>
<tr>
<td>Students tend to confuse the calculator buttons</td>
<td>0%</td>
<td>6%</td>
<td>3%</td>
<td>32</td>
<td>59</td>
</tr>
<tr>
<td>Average percentage</td>
<td>7%</td>
<td>9%</td>
<td>0%</td>
<td>30</td>
<td>54</td>
</tr>
</tbody>
</table>

As indicated in table 4.4, 56% strongly agreed that scientific calculators can improve teacher’s attitude in mathematical computations while 6% strongly disagreed. This thus means that scientific calculator has a high impact on teacher’s attitude towards mathematics subject. Also 51% strongly agreed that students enjoy solving problems with calculators while 3% disagreed. It means that scientific calculators make students enjoy performing Mathematical computations. On whether scientific calculators tend to make students lazy, 53% of the teachers agreed while only 8% disagreed. It shows that a substantial
number of teachers (87%) believed that some students tend to be lazy especially when solving problems that require critical thinking as according to (Surgenor et al., 2007). Majority (59%) of the teachers strongly agreed that students confuse the calculator buttons while 6% disagreed. This suggests that most students have a challenge in effective use of the scientific calculators.

4.6 Students' Attitude towards use of Scientific Calculator

Students were asked about their opinion on calculator usage and generally their attitude towards mathematics after introduction of scientific calculators so as to determine their overall attitude and whether their attitude towards mathematics was related to gender and school category.

4.6.1 Students' overall Attitudes towards use of scientific Calculators

Students' opinions were sought on scientific calculator usage and their general attitude towards mathematics so as to determine whether their attitudes towards scientific calculator and mathematics do affect the learning processes and their overall achievement. The summary of the students' on general attitude towards calculator use are as shown in Table 4.5.

<p>| Table 4.5: Students' overall attitude analysis towards scientific calculator |
|---------------------------------|------------|-------|-------|-------|-------|</p>
<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>U</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always use my calculator whenever solving mathematical problems</td>
<td>8%</td>
<td>6%</td>
<td>5%</td>
<td>29%</td>
<td>52%</td>
</tr>
<tr>
<td>I sometimes prefer to use paper and pencil to calculator when computing mathematics</td>
<td>11%</td>
<td>4%</td>
<td>4%</td>
<td>26%</td>
<td>55%</td>
</tr>
</tbody>
</table>

Key: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (SA)
| Over dependence on calculator makes me lazy even to basic computation problems | 6% | 9% | 6% | 38% | 41% |
| I have more confidence in my ability to deal with mathematics when I have a calculator | 28% | 12% | 1% | 22% | 37% |
| Calculation is easier if calculators are used | 60% | 25% | 0% | 7% | 8% |
| Calculators make mathematics fun | 29% | 13% | 5% | 14% | 39% |
| The use of a calculator confuses me | 58% | 26% | 2% | 8% | 6% |
| I feel that calculators not be used in math tests | 48% | 36% | 4% | 4% | 8% |
| Calculator use in mathematics develops critical thinking in solving problems | 29% | 12% | 1% | 20% | 38% |

The students interviewed agreed (52%) that they always use scientific calculators whenever solving mathematical problems but will sometimes prefer to use paper and pencil to the calculator when computing mathematical problems. This implies that students’ attitude towards Mathematics is not affected by the presence of the scientific calculators alone. The students also agreed (41%) that over dependence on scientific calculators makes them lazy even to basic computation problems and that, they become more confident in their ability to deal with mathematics when they apply scientific calculators. This suggested that students depended on scientific calculators to perform basic arithmetic computations. The scientific calculators also boost students’ confidence towards Mathematics.

When asked if calculations became easy when scientific calculators are engaged in solving mathematical problems and if calculators make mathematics fun, the
students strongly disagreed (60%). This implies that students see mathematics as a difficult subject even if scientific calculators are used to perform mathematical computations. Students also gave their opinions on whether the use of a scientific calculator confuses them and whether scientific calculators should not be used in mathematical tests. They strongly disagreed (58%). This implies that students prefer to use scientific calculators during Mathematical tests.

Even though most of the findings from the literature reviewed indicate that students hold positive attitudes towards calculator usage in mathematics, Ruthven (1996) states that some students hold negative attitudes towards calculator usage in mathematics. As noted in the literature, these students find that calculator usage does not aid them in the learning of Mathematics as they lack confidence in the calculator as a way of learning problem solving skills. Fifty three percentage of the teachers interviewed agreed that use of scientific calculators tends to make students lazy in dealing with Mathematical computations. These results disagree with Ruthven’s assertions in 1996 that since students have tremendously embraced the use of technology; the calculator has become ubiquitous. Supporting Abdullah et al. (2005) claimed that students have had a broad exposure to calculator usage and have a positive acceptance of the use of the calculator in the mathematics classroom. From the literature, the report “Pressing the right buttons: calculator use in schools and Junior Cycle Mathematics” (Surgenor et al. 2007) reported that;

“One of the main perceived disadvantages of calculator use in the mathematics classroom was students’ difficulty in using the calculator”(p. 24).
The results obtained from this study found that 59% of the teachers interviewed agreed that students tend to confuse the calculator buttons. An assumption made in this study is that since 2005 there has been a substantial increase in calculator usage within Kandara sub-county secondary schools. Close, Oldham, Surgenor, Shiel, Dooley and O'Leary (2008) found that 81% of Irish third year students surveyed in 2008 stated that;

"Students used a calculator often in a mathematics class yet, less than 1% reported using a calculator in 2000" (p.72).

The evidence obtained from this study indicate that learners have developed positive attitude towards calculators and have become more exposed in technology and thus no longer regard the scientific calculator as difficult to use.

4.6.2 Students’ Attitudes towards use of scientific Calculator by Gender

Students were asked to state their gender and this was used determine if it affected their attitude towards use of calculators. There were a total of 157 males and 91 female students. Table 4.6 shows the comparison of students’ attitude towards scientific calculator by gender.

Table 4.6: Students’ attitude towards scientific calculator use by gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>G</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always use my calculator whenever solving mathematical problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>G</td>
<td>6%</td>
<td>9%</td>
</tr>
<tr>
<td>I sometimes prefer paper and pencil to calculator when computing problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>11%</td>
<td>4%</td>
</tr>
<tr>
<td>Over dependence on calculator makes me lazy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>G</td>
<td>7%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Both male and female students interviewed agreed (Boys: 54%, Girls: 51%) that they always use scientific calculators whenever solving mathematical problems and strongly agreed that they would sometimes prefer to use paper and pencil when computing mathematical problems. This implies that scientific calculators have the same effect on both male and female students’ attitude towards Mathematics. Again both male and female students agreed (Boys: 47%, Girls: 49%) that over dependence on scientific calculators makes them lazy and will depend on the calculator to solve even basic computation problems.

When students were asked if scientific calculators have made them more confidence in their ability to deal with mathematics, only male students agreed (51%) while their female counterparts strongly disagreed (62%). This suggested
that male students had little difficulty on use of scientific calculators to perform basic arithmetic computations than the female students as per (Surgenoret al. 2007) who reported that;

“One of the main perceived disadvantages of calculator use in the mathematics classroom was students’ difficulty in using the calculator”.

The scientific calculators have boosted male students’ confidence towards Mathematics (80%) more than female students (26%). The students were also asked if Mathematics becomes easy when scientific calculators are used in solving problems and if calculators make mathematics fun, both male and female students strongly disagreed (Boys: 66%, Girls: 74%). This implies that both male and female students agree that scientific calculators do not make Mathematics easy when used to perform mathematical computations since they must first learn the basics without the aid of a calculator as opposed to the usage of the calculator in conjunction with traditional mathematics as suggested by Odhiambo and Toili (2013). Students were also asked their opinion on whether the use of a scientific calculator confuses them and whether scientific calculators should not be used in mathematical tests. Both male and female students strongly disagreed (Boys: 87%, Girls: 71%). This implies that both male and female students consider scientific calculators as an important gadget for solving Mathematical tests supporting the findings of Dunham and Dick (1994). The results in the table show that there is a positive attitude which has been developed by students towards scientific calculators. However the areas of confidence and problem-solving show some negative attitudes.
4.6.3 Significance of Students’ Attitude towards calculator by Gender

Students’ responses on variables investigating their attitudes towards scientific calculator were tabulated. An analysis by t-test was conducted to determine the significance of their (students) attitude towards scientific calculator use by gender. The differences in attitude as a result of using scientific calculators with their level of statistical significance are tabulated as shown in table 4.7.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always use my calculator whenever solving mathematical problems</td>
<td>27.26</td>
<td>25.38</td>
</tr>
<tr>
<td>I sometimes prefer to use paper and pencil to calculator when computing problems</td>
<td>34.01</td>
<td>26.41</td>
</tr>
<tr>
<td>Over dependence on calculator makes me lazy even to basic computation problems</td>
<td>31.01</td>
<td>23.38</td>
</tr>
<tr>
<td>I have more confidence in my ability to deal with mathematics when I have a calculator</td>
<td>20.95</td>
<td>17.03</td>
</tr>
<tr>
<td>Calculation is easier if calculators are used to solve problems</td>
<td>21.59</td>
<td>19.67</td>
</tr>
<tr>
<td>Calculators make mathematics fun</td>
<td>21.84</td>
<td>22.41</td>
</tr>
<tr>
<td>The use of a calculator confuses me</td>
<td>4.433</td>
<td>40.54</td>
</tr>
<tr>
<td>Calculators should not be used in math tests</td>
<td>44.01</td>
<td>46.37</td>
</tr>
<tr>
<td>Calculator use in mathematics develops critical thinking in solving problems</td>
<td>29.80</td>
<td>21.78</td>
</tr>
</tbody>
</table>

The t-test gave a \( p=0.343, \alpha=0.05 \) on whether students always use their calculators whenever solving mathematical problems. Since 0.343 > 0.05, it shows that the responses of boys’ were significantly different from the girls’. This suggests that there was difference in the way boys use scientific calculators in learning Mathematics from the girls. The t-value \( p=0.008, \alpha=0.05 \) for over dependence on calculator makes students lazy even to basic computation.
problems, it shows that the responses of boys were not statistically different from the girls. This implied that both male and female students have similar opinions towards the use of scientific calculators in line with Surgenor et al. (2007) who reported that;

"Students who were negatively disposed to the calculator felt that calculator usage would make them lazy, had lower performance levels on each of the calculator tests in comparison with students who did not hold such views" (p. 24).

On whether scientific calculators have improved students' confidence towards Mathematics, the responses were not significantly different ($p=0.018$, $\alpha=0.05$). This implied that both male and female students agreed that confidence towards Mathematics had improved. This is in agreement with Dunham and Dick (1994) who suggested that calculators increase the student participants' confidence.

Concerning whether scientific Calculator use in mathematics leads to developing of critical thinking while solving problems by learners, $t$-test gave a ($p=0.988$, $\alpha=0.05$) which was significantly different implying that there was a difference between boys and girls on developed attitudes towards calculators. This concurs with Dunham (1995) that;

"Calculator use results in more positive feelings and better attitudes about calculators for both students and teachers" (p. 105).

Recent research has also shown that there is a significant difference between students' behavior and performance of male and female students (Parker and Claxton, 1996). The reasons for those differences can be categorized as both biological and sociological. It is reported that in secondary schools, most of the female students do not actively participate in while learning mathematics due to
their poor perception towards the subject. Girls become influenced negatively by their sex-influence stereotypes (Ethington, 1992). This was unlike indicated by Hassan et al. (2012) where female students performed better and had positive attitudes than male students in Mathematics.

4.6.4 Students’ Attitude towards Calculator usage by School category

Data was collected from students to determine if the school category had an impact on attitude towards calculator usage in learning of mathematics. The categories were; boys’ boarding schools, girls’ boarding school, mixed day school and mixed boarding schools. Student responses from these categories were used to gauge whether a school category actually has an impact on their attitude change due to incorporation of scientific calculator. Table 4.8 shows the analysis of students’ attitude towards calculators as per school category.

Table 4.8: Students' attitude towards calculators by school category

Key: Agree (A), Disagree (D), Boys’ boarding, (BB), Girls’ boarding (GB), Mixed day (MD), Mixed boarding (MB)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Opinion</th>
<th>BB</th>
<th>GB</th>
<th>MD</th>
<th>MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>I always use my calculator whenever solving problems</td>
<td>A</td>
<td>61</td>
<td>66</td>
<td>49</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>37</td>
<td>33</td>
<td>41</td>
<td>43</td>
</tr>
<tr>
<td>I sometimes prefer using paper and pencil to calculator when computing</td>
<td>A</td>
<td>57</td>
<td>76</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>mathematical problems</td>
<td>D</td>
<td>25</td>
<td>23</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>Dependence on calculator makes me lazy even to basic problems</td>
<td>A</td>
<td>50</td>
<td>60</td>
<td>42</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>46</td>
<td>36</td>
<td>55</td>
<td>36</td>
</tr>
<tr>
<td>I have more confidence in my ability to deal with mathematics when I</td>
<td>A</td>
<td>68</td>
<td>7</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>have a calculator</td>
<td>D</td>
<td>25</td>
<td>93</td>
<td>77</td>
<td>80</td>
</tr>
</tbody>
</table>
Calculation is easier if calculators are used to solve problems

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>73</td>
<td>83</td>
<td>79</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>23</td>
<td>16</td>
<td>22</td>
</tr>
</tbody>
</table>

Calculators make mathematics fun

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>23</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>77</td>
<td>66</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

The use of a calculator confuses me

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>4</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>91</td>
<td>87</td>
<td>57</td>
<td>7</td>
</tr>
</tbody>
</table>

I feel that calculators should not be used in math tests

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>0</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>88</td>
<td>10</td>
<td>85</td>
<td>83</td>
</tr>
</tbody>
</table>

Calculator use in mathematics develops critical thinking in solving problems

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>42</td>
<td>30</td>
<td>57</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>37</td>
<td>38</td>
<td>47</td>
</tr>
</tbody>
</table>

Students from all school categories interviewed agreed that they always use scientific calculators whenever solving mathematical problems with girls' boarding having the highest (66%) and strongly agreed that they sometimes use paper and pencil as component to the calculator when computing mathematical problems. This implies that all students in these schools have access to scientific calculators but consider paper and pencil method as an important method when solving Mathematical problems thereby supporting the findings by Antonijevic (2005) that students with no calculator access in the Mathematics classroom have to understand all the abilities and skills involved in performing calculations which consequently leads these students to attain better scores in Mathematics.

Student participants from all the sampled school categories agreed that over dependence on scientific calculators makes them lazy and will depend on the calculator to solve even basic computation problems with girls' boarding having the highest proportion of students (60%). When they were asked if scientific calculators have made them more confident in their ability to deal with
mathematics, only students from boys boarding schools agreed (68%) while those from girls boarding (7%), mixed day (18%) and mixed boarding disagreed (11%). This suggested that students from boys' boarding schools have developed more confidence towards Mathematics due to scientific calculators than those from other school categories as reported by Parker and Claxton, (1996) that there is a significant difference between behaviors and performance of male and female students. This again tends to suggest that scientific calculators have boosted male students' confidence towards Mathematics more than female students confirming the findings of Stuart (2000); that calculators reduces mathematics anxiety among students as had been suggested Dunham and Dick (1994); that calculators increase enthusiasm in Mathematics, accordance with Countryman and Wilson (1991), and that calculators improve students' attitude toward the mathematics subject.

The students were then asked if calculations in Mathematics had become easier when scientific calculators are used to solve problems and if calculators make mathematics fun. Students from all school categories disagreed (with percentages ranging from 14-26%). This implies that majority of students irrespective of school category and access to scientific calculators agree that scientific calculators alone do not make Mathematics easy when used to solve mathematical problems supporting Engineers Ireland (2008) claim that the reliance on calculators in early school will leads to a decline in some aspects of a students' numeracy skills. Students gave their opinions on whether the use of
a scientific calculator confuses them, where students from all school categories strongly disagreed with boys boarding with highest (91%).

On whether scientific calculators should not be used in mathematical tests, they all disagreed with girls’ boarding (10%), which implies that students from all school categories prefer scientific calculators use which could lead to overreliance on calculators which according to Hembree and Dessarts (1986) have a negative impact on the paper-and-pencil skills of students at one particular grade level, fourth grade (primary school). Also students from all school categories agreed that calculator use in mathematics develops critical thinking in solving problems which supports Ellington (2003) that when used appropriately, calculators enhance students learning of mathematics. Generally, the students have developed positive attitude towards mathematics has in all the school categories. This implies that scientific calculators have resulted in positive students’ attitude towards mathematics in all school categories and that they have been considered important gadgets in teaching and learning of Mathematics supporting Tsao 2006 claim that students who are exposed to a constructivist-based learning approach gain positive attitudes toward the subject.

4.6.5 Significance of students’ attitude by school category

The results of students’ attitudes by school category were subjected to one way ANOVA to determine whether there is any significant difference among the four groups of the school category. The results are as shown in Table 4.9.
Table 4.9: ANOVA on students' attitude towards calculators by school category

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4459.764</td>
<td>7</td>
<td>637.109</td>
<td>0.920</td>
<td>0.497</td>
</tr>
<tr>
<td>Within Groups</td>
<td>44312.889</td>
<td>64</td>
<td>692.389</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48772.653</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A one way ANOVA gave a \((p=0.497, \alpha=0.05)\) on whether the students' attitude towards calculators were significantly different among the four school categories. Since 0.497 > 0.05, it shows that the students' attitudes towards calculators in the four schools categories were statistically different. This suggests that students from the four categories of schools have developed attitudes towards scientific calculators differently; which could be due to girls being negatively influenced by their sex-influence stereotypes (Ethington, 1992), also by Pomerantz (1997) that the calculator is essential in learning and teaching mathematics and can be quite effective aid when it comes to problem solving.

4.6.6 Relationship between gender and Students' attitudes to calculators

The data for the students' opinion on attitude towards Mathematics was subjected to a chi-square test of relationship between gender of students and attitudes towards mathematics. The findings showed in table 4.10 below.
Table 4.10: Chi-square on Relationship between students’ gender and attitude

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>96.00</td>
<td>93</td>
<td>0.395</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>91.49</td>
<td>93</td>
<td>0.525</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>0.042</td>
<td>1</td>
<td>0.837</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The student responses on whether over dependence on scientific calculators makes them lazy even to basic computation problems was not statistically different \((p=0.395, \alpha=0.05)\) in terms of gender. Male students and female students’ responses were similar in opinion. This suggests that there was no difference in the level of attitude towards calculator between male and female students as a result of use of scientific calculators at secondary school level. There was a significant difference in responses by students on whether the use of scientific calculators confuses them. This implies that the level of proficiency in the use of scientific calculators between male and female students is different. The responses on whether scientific calculators have made them more confident to deal with mathematics was also not significantly different implying that both male and female students fear Mathematics as difficult subject even with use of calculators. Responses by male and female students on whether calculations in Mathematics had become easier with use of calculators to solve problems were not significantly different suggesting that both boys and girls agree that scientific
Calculators alone do not make Mathematics easy but understanding of concepts was important when solving Mathematical problems which consistently agrees with the findings of Noraini (2004) who concluded that calculators should not act as a substitute during learning when doing mental operations but should serve as a tool that allows learners explore and thereafter teachers should elaborate on the methodologies used. Therefore students should be guided to develop good computational skills without scientific calculators before they access scientific calculators. From the study findings on determining the teachers’ and learners’ attitude and their effect on the usage of scientific calculators in teaching and learning of Mathematics in secondary schools, it can be concluded that the use of scientific calculators has supported the teacher’s and students’ attitude towards mathematics.

4.7 Learners’ computational skill development in pre-test and post-test

Objective three was to determine the extent to which scientific calculators’ aid in computational skill development among learners in secondary schools. Therefore the pre-test measured the students’ ability to carry out a mathematics assignment without the aid of a calculator. The post-test measured the students’ ability to carry out a mathematics assignment with the use of a calculator. The results were analyzed to determine the overall student performance, performance by students according to ability level, performance by students according to mathematics content area and level of calculator use by learners.
4.7.1 Scientific calculators and Students’ computational ability

The overall performance of students’ computational ability in mathematics is as shown in Table 4.11.

Table 4.11: Students' Performance level and scientific calculators

<table>
<thead>
<tr>
<th>Content area</th>
<th>Pre - test</th>
<th>Post – test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Item</td>
<td>Mean Std. Dev</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>1</td>
<td>35.82 0.396</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>46.2 0.499</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>45.33 0.501</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>55.17 0.369</td>
</tr>
<tr>
<td>Logarithms</td>
<td>1</td>
<td>53.46 0.414</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>58.8 0.197</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>50.7 0.463</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>28.92 0.187</td>
</tr>
<tr>
<td>Squares, cubes and</td>
<td>1</td>
<td>45.41 0.361</td>
</tr>
<tr>
<td>reciprocals</td>
<td>2</td>
<td>35.41 0.372</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>47.21 0.367</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>36.88 0.421</td>
</tr>
</tbody>
</table>

The students’ mean scores and a show of correct methodology used during calculations were used to gauge the level of computational skills and overall performance. From Table 4.11, the analysis of the results shows that there was an improvement on mathematics scores for the post-test (with use of scientific calculators) as compared to pre-test scores (without use of scientific calculators). The analysis shows that performance in Mathematics improved with the introduction of calculators supporting the idea that calculators improve students’ ability to solve problems (Dunham and Dick, 1994).
On the pre-test, student participants scored an average mean score of 44.94%. In comparison, student participants scored an average mean score of 55.45% on the post-test, an average increase of 10.51% in proficiency when the calculator was available. These results indicate a difference between the pre-test and post-test scores. The results were further subjected to one way ANOVA to determine whether there was any significant difference among the pre-test and post test scores as a result of acquired Mathematical computational skills by learners. The results are as shown in Table 4.12.

Table 4.12: An ANOVA test on pre-test and post-test scores

<table>
<thead>
<tr>
<th>Key: df = degrees freedom, F = statistic at α=0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of Squares</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Between Groups</td>
</tr>
<tr>
<td>Within Groups</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

One way ANOVA gave a \( p=0.016, \alpha=0.05 \). Since the \( p \)-value \( (0.016) < 0.05 \), it shows that the differences in means in the pre-test and post-test scores were not significantly different. This suggests that scientific calculators did not improve the overall performance of students in Mathematics which disagrees with findings of Ellington (2006) that calculator use improves the mathematical performance of student participants in the subject of mathematics at secondary school level.
However, since the pre-test and post-test scores were not significantly different, it could also suggest that the scientific calculators had not aided students in their computational skills. This implies that students have become reliant on the scientific calculator which compromises their computational skills which leads to poor performance in Mathematics. This as indicated by Reynolds and Farrell (1996) who suggested that introduction of calculators into the mathematics classroom and when frequently used, contributes to the relatively poor performance by learners in mathematics.

4.7.2 Students computational skills by gender

In order to analyze, the effect of calculator usage on students’ computational skills development by gender, the test scores were grouped by the students’ gender (girls or boys). Table 4.13 shows the difference in the respective pre-test and post-test mean scores of each gender group in favor of calculator access.

Table 4.13: Students’ performance on pre-test and post-test by gender

<table>
<thead>
<tr>
<th>Content area</th>
<th>Item</th>
<th>Gender</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev</td>
</tr>
<tr>
<td>Trigonometry</td>
<td>1</td>
<td>Boys</td>
<td>36.30</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>35.92</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Boys</td>
<td>48.94</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>43.17</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Boys</td>
<td>47.19</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>42.18</td>
<td>0.49</td>
</tr>
</tbody>
</table>
The boys who participated in the study registered a higher mean gain in mathematics performance, with an average increase of 17% in proficiency when the calculator was available. The effect size associated with this difference is large (Cohen, 1988). Interestingly, the lowest pre-test score by boys was 46% (6% above the standardized pass rate) in comparison with the lowest post-test score by female students 35% (15% below the standardized pass rate) an increase of 21%. The increase in the student’s scores indicates the level of proficiency in the use of scientific calculator.
The greatest gain registered by student participants was 17%; question 2 of logarithms had a score of 59% in the pre-test and a score of 76% in the post-test (student reported highest score in calculator usage in the post-test). However, question 2 of Squares, cubes and reciprocals had the lowest a score of 52% in the pre-test and a score of 37% in the post-test (student reported lowest score in calculator usage in the post-test). Generally boys indicated better computational skills than girls in Logarithms, Squares, cubes and reciprocals while girls had better computational skills than boys in Trigonometry but indicated lowest computational skills in Squares, cubes and reciprocals as supported by pre-test scores.

As reflected in Table 4.14, the girls did not benefit from access to a calculator to the same extent as their male counterparts in form three. The reason for the difference can be categorized as either biological or sociological as Parker and Claxton, (1996) indicated that there exists differences between students' behavior and performance of male and female students also according to Ethington (1992) that girls become negatively influenced by their sex-role stereotypes.

Table 4.14: Further analysis of student computational skills by gender

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gende</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td>r</td>
<td>n</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>----------------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>Trigonometry</strong></td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>91</td>
</tr>
<tr>
<td><strong>Logarithms</strong></td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>91</td>
</tr>
<tr>
<td><strong>Squares, cubes and</strong></td>
<td>Boys</td>
<td>15</td>
</tr>
<tr>
<td>reciprocals**</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>

n = number of student participants = 248

4.7.3 Students’ computational skills by school category

In order to analyze, the effect of calculators on computational skills development based on school category, the performance results are categorized and grouped by the school category as; Boys boarding, girls boarding, mixed boarding and mixed day schools. Table 4.15 provides a breakdown of the students’ performance on the pre-test (without a scientific calculator) and post-test (with use of scientific calculator) by school category.
As reflected in Table 4.15, the students studying at boarding schools did not benefit from access to a calculator in developing computational skills to the same extent as their counterparts studying at day schools. Student participants studying at mixed day registered the highest mean of 65% with use of a calculator compared to 57% without use of a calculator having an average increase of 8% in when the calculator was available. The effect size associated with this difference is large (Cohen, 1988). This implied that the calculators had not supported the students' computational skills to enable them solve...
Mathematical problems without calculators as compared to their counterparts from other school categories. However, the lowest pre-test score by a student participants was 40% (5% below the standardized pass rate) in comparison with the lowest post-test score by student participants of 46% (1% above the standardized pass rates an increase of 1%. The students’ mean scores for the pre-test and post-test for the four school categories sampled were summarized as presented in table 4.16.

Table 4.16: Further analysis on students’ skills by school category

<table>
<thead>
<tr>
<th>School Category</th>
<th>n</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Boys boarding</td>
<td>78</td>
<td>54.94</td>
<td>8.83</td>
</tr>
<tr>
<td>Girls boarding</td>
<td>30</td>
<td>47.60</td>
<td>12.62</td>
</tr>
<tr>
<td>Mixed day school</td>
<td>49</td>
<td>51.48</td>
<td>12.06</td>
</tr>
<tr>
<td>Mixed boarding school</td>
<td>91</td>
<td>53.40</td>
<td>9.98</td>
</tr>
</tbody>
</table>

N= Number of students by school category=248

The greatest gain registered by a school category was 7.4% in mixed boarding schools with an average score of 53.4% in the pre-test and an average score of 60.8% in the post-test. Student participants studying boys’ boarding schools registered an average decrease of 0.6% in performance when the calculator was available (Figure 4.2). This could mean that the scientific calculator use does not always translate into higher test scores. This implied that students’ Mathematical skill development varied with school category due to the use of scientific
calculators as discussed in the literature review that calculator usage within the mathematics classroom could affect a student’s mastery of basic computational skills acquired through the traditional process of paper-and-pencil methods (NCTM, 1974).

Figure 4.2 Graph of students' pre-test and post-test mean scores

4.7.4 Students’ computational skills by Mathematics content area

In order to analyze, the effect of calculator usage on students’ computational skills development and performance by content area, the test results were grouped by Mathematics content area tested. Table 4.17 provides a breakdown on students’ performance on the pre-test (without calculator access) and post-test (with calculator access) by content area.
Table 4.17: Students’ computational ability by Mathematical content area

<table>
<thead>
<tr>
<th>Content area</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
<th>Percent of correct methodology applied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td></td>
</tr>
<tr>
<td>Trigonometry</td>
<td>45.42</td>
<td>12.87</td>
<td>59.44</td>
<td>8.85</td>
<td>66.67</td>
</tr>
<tr>
<td>Logarithms</td>
<td>55.32</td>
<td>9.12</td>
<td>76.27</td>
<td>11.64</td>
<td>49</td>
</tr>
<tr>
<td>Squares, cubes and reciprocals</td>
<td>54.84</td>
<td>10.59</td>
<td>60.88</td>
<td>14.22</td>
<td>45.31</td>
</tr>
</tbody>
</table>

n=Total student participant=248

The students registered the greatest average mean difference between their pre-test and post-test scores in the Logarithms section (20.9), followed by the Trigonometry section (14.02). The least gain by student participants between their pre-test and post-test scores was in the section on Squares, cubes and reciprocals (6.04). This implied that students had lower computational skills and thus depended more on calculators in Logarithms, Trigonometry as compared to square cubes and reciprocals. It could also suggest that many students were unable to use the calculator for the calculation of Squares, cubes and reciprocals because they had not have received appropriate instruction for the calculation of Squares, cubes and reciprocals using a calculator, making the calculator less beneficial to them in computing Squares, cubes and reciprocals compared to other sections. As reflected in table 4.17, the calculator had the most significant effect on students’ participants’ performance in the section on Logarithms with
an average increase of 21% in proficiency when the calculator was available, and in the Trigonometry section with an average increase of 19% in proficiency when the calculator was available.

The least gain by student participants was in the section on Squares, cubes and reciprocals with an average increase of 6%. It is evident from the analysis of the post-tests that many students were unable to use the calculator for the calculation of Squares, cubes and reciprocals. However, it was observed that the content area of Logarithms which had the greatest average increase in its score also reported the highest level of items successfully completed by student participants. This observation may indicate three things; the student’s efficiency in the use of a calculator can lead to greater test scores (as seen in the post-test) as supported by Pomerantz (1997) that calculator usage will support students computational abilities thus allowing them to complete more questions; or that a student efficiency in the use of a calculator for specific mathematical computations creates a students’ reliance on the calculator to the point of being unable to perform the computation by paper-and-pencil (as seen in the pretest) disagreeing with Smith (1997) who reported that calculators use does not impede the students’ development of paper-and-pencil skills; or that or that student’s efficiency in the use of a calculator can lead to improved time management and better test scores (as seen in the post-test) errors supporting claims from NCTM 2000, that calculator usage will support students computational abilities and reduces computational time thus allowing students to complete more test questions.
The findings on determining the extent to which scientific calculators aid in computational skill development among learners in secondary schools suggest that scientific calculators improved the overall performance of students in Mathematics supporting Ellington (2006) assertions that calculator use improves the mathematical performance but students had low computational skills as shown in pre-test and post test scores and that students have become reliant on the scientific calculator which compromises their computational skills which leads to poor performance in Mathematics as indicated by Reynolds and Farrell (1996) who suggested that their too frequent use is can lead to poor performance of students in mathematics.

4.8 Students Preparedness for Effective use of Scientific Calculators

The researcher sought to find out whether the students had been effectively trained to use scientific calculators during computations and examinations and the responses are indicated in Figure 4.3.

![Pie-chart of students' preparedness on use of calculators](image)

**Figure 4.3: Pie-chart of students' preparedness on use of calculators**

Majority (48%) of the students strongly disagreed that they are effectively trained by their teachers on the use of scientific calculators. Only 8% of the student participants agreed that they are effectively trained to handle scientific
calculators when performing Mathematical computations. This implied that majority (48%) of the students are not able to effectively use the scientific calculators to effectively perform Mathematical computations because from (figure 4.3), (48%) of teachers do not effectively train students on to use scientific calculators during the teaching and learning mathematics. This is also according Taylor (1994) who also noted that, teachers who have no interest in using instructional technologies while teaching need some incentives and support from school administrators. Thus the Ministry of Education has noted that, lack of resources and adequate preparation; teachers are likely not to embrace use of technology. Moreover meaningful learning only takes place in an environment where students are actively engaged in focused and sequenced activities for acquisition of knowledge and skills. Due to this challenge, learners tend to develop negative attitude towards calculator use. Therefore, teachers should embrace new technologies and effectively train students in their use so as to increase the impact of calculators on students’ Mathematical performance.

The findings on the extent of scientific calculators use in teaching and learning of Mathematics in Kandara was that scientific calculators are widely used by students and learners in Kandara Sub County although 46% of the students disagree that there are adequate scientific calculators in classrooms and that those available are sometimes are not in good working condition which means that these calculators are not readily available to all students. Also 75% of the teachers do not always use calculators while teaching Mathematics which means that learners do not get sufficient knowledge in the use the scientific calculators
when learning Mathematics. Even though 48% of students were found to have been encouraged to use scientific calculators by their Mathematics teachers in solving mathematics problems, the study showed that it was only 52% of the Mathematics teachers who adequately guides them in the use of scientific calculators yet only 48% of the students are effectively trained by their teachers on the use of scientific calculators. The study also found that 71% of students do not always use calculators while 68% of the students can access scientific calculators which could suggest that although these scientific calculator are available to almost all students, a high percentage of them do not always use them or never use them yet NCTM (2000) claims that calculator usage supports students’ computational abilities development.

4.9 Scientific Calculator usage and Mathematical Performance

Objective four was to investigate the influence of scientific calculators on student mathematics performance. The teachers were asked whether there was a difference in performance between students who regularly use scientific calculators from those who does not use them in computing mathematical problems where the results are as shown in figure 4.4.
A majority (65%) of teachers agreed that there was a difference in performance while only 6% of the teachers strongly disagreed that there was a difference in performance between students with use of scientific calculators from those who does not use them. It was therefore clear that teachers agreed that scientific calculators improve Mathematical performance of learners supporting Abdullah, Abdullah and Tap (2005) claim that;

"Students have had a broad exposure to calculator usage and have a positive acceptance of the usage of the calculators in the mathematics classroom"(p.24).

This could be possible since scientific calculators improved time management of the learners while solving Mathematical problems. Also 55% of the teachers agreed that since the introduction of calculators, they were able to complete the syllabus in time since calculator saves time during instruction especially in form three while 35% of the teachers disagreed. What this means is that the use of
scientific calculators has improved the teacher's time management in attitude towards mathematics.

The evidence obtained from this study indicated that mathematics teachers in Kandara Sub-county have a positive attitude towards the usage of the scientific calculator in the mathematics classroom. In accordance with Suydam (1976) the teachers interviewed for this Study agreed that in order for students to benefit from use of scientific calculators and improve their performance as well as improve in their mathematics learning, they must first learn the basics without the aid of a calculator as opposed to the usage of the calculator in conjunction with traditional mathematics as suggested by Odhiambo and Toili (2013).

The research result obtained in this Study also gives support to the findings by Antonijevic (2005) that students with no calculator access in the Mathematics classroom have to master all the skills and abilities in an area of calculations which consequently leads these students to attain better scores in Mathematics. Despite the improved teachers' attitude towards Mathematics, due to scientific calculators, this has not translated into improved Mathematics performance in Kenya (Table 1.1). This means that improved teachers' attitude alone does not improve students' performance in Mathematics.
CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

The main purpose of this study was to bridge the current gap in research in the Kenyan context by conducting an investigation into the influence of scientific calculator usage on secondary mathematic students. Thus this study achieved this goal by examining the influence of scientific calculators on attitude change of students and teachers toward calculator usage; and student attitudes towards the mathematics subject. This chapter reflects on the main research findings from chapter four in reference to the literature review from chapter two.

5.2 Summary of findings

The findings indicated that majority i.e 75% of the teachers do not always use a calculator while teaching Mathematics which can limit learners of sufficient knowledge in the use the scientific calculators when learning Mathematics. Some students (46%) disagree that there are adequate scientific calculators in classrooms and that those available are sometimes not in good working condition.

Also 48% of students get encouraged by their Mathematics teachers to use scientific calculators every time when solving mathematics problems but (52%) disagree those teachers adequately guide them in the use of scientific calculators. Only (48%) of the students strongly were effectively trained by their teachers on the use of scientific calculators.
The findings indicated that teachers (56%) were very positive towards the usage of the calculator in mathematics. The teachers (55%) also stated that the calculator helps complete the syllabus in time since calculator saves time during instruction and students improve attitudes toward the mathematics subject. The teachers (53%) expressed fears that the too much use of the calculator by students in secondary schools makes them lazy. 65% of teachers agreed that there is a difference in performance between students who use scientific calculators from those who do not use them.

The research also found that a statistically significant difference \( (p=0.016, \alpha=0.05) \) existed between student participants’ pre-test mean score (without the use of the calculator) and student participants’ post-test mean score (with use of the calculator). The results obtained further demonstrated that the use of the calculator does not increase the students’ performance level in mathematical computations. By mathematical content area, the greatest significance difference in students’ participants’ pre-test and post-test scores was in the section on Logarithms. The least gain by student participants between their pretest and post-test scores was in the section on squares cubes and reciprocals. However, since the pre-test and post-test scores were not significantly different, it could also suggest that these students had not improved their computational skills and therefore achieved significantly similar scores even with scientific calculators. This implies that students have become reliant on the scientific calculator which compromises their computational skills which leads to poor performance in Mathematics as indicated by Reynolds and Farrell (1996) who suggested that
introduction of calculators into the mathematics classroom and their too frequent use is one of the reasons for relatively poor performance of students in mathematics.

Since the students had the greatest average mean difference between their pre-test and post-test scores in the Logarithms section (20.9), followed by the Trigonometry section (14.02) while the least gain was in the section on Squares, cubes and reciprocals (6.04), it implied that students had not improved their computational skills and thus depended more on calculators in Logarithms, Trigonometry as compared to square cubes and reciprocals.

One major challenge in the use of scientific calculators as noted by teachers was the lack of a uniform policy on their use and thus it was important to implement a uniform calculator policy within the secondary school mathematics education system. At the moment, secondary schools have no calculator usage policy in place to allow teachers teach at the same level use uniform policies of scientific calculator.

5.3 Conclusion

This study established that:

- Scientific calculators have not aided in the development of computational skills among secondary school students during mathematics instruction.

- Scientific calculators have not influenced positively students’ mathematics performance.

- Scientific calculators have not been fully incorporated in the teaching and learning of mathematics in Kandara sub County.
5.4 Implications of findings for practice

Mathematical proficiency plays an essential influence for living and working in today's modern society and thus students with a poor level of mathematical ability will have limited opportunities to pursue higher levels of education. Therefore all secondary school students need to achieve mathematical proficiency in order to achieve this goal. According to objective one, the study showed that scientific calculators are not fully incorporated in mathematics learning and also not in good working conditions. Therefore all secondary schools need to ensure that all students have access to calculators and teachers of mathematics are trained well on how to use them so as to transfer the same to their students.

According to IUA, (2008), negative attitude or anxiety toward the mathematics discipline is thought to affect learners at every level of post-primary school. Therefore there is a challenge in the secondary education system to provide students in Kenya with the mathematical knowledge, skills, understanding and confidence needed for life and work in the 21st century. Advancement in technology such as the scientific calculator has an intense effect on the way students' learn Mathematics in secondary schools in Kenya. This study showed that scientific calculators use makes it easier for students to perform Mathematical calculations and that they make students have a more positive attitude towards Mathematics subject.
It is crucial to point out that although many research studies have shown that the introduction of the calculator into a students learning environment doesn’t always demonstrate positive results. This study sought to find out if scientific calculators support students’ ability to execute Mathematical computations. The results showed scientific calculators had not aided in mathematical computation skills development resulting in poor mathematical literacy.

5.5 Recommendations

The appropriate use of the calculator would encourage students to actively participate in their own learning as indicated by the research evidence in this study, since the literature review also supported that students who are exposed to a “constructivist” based learning approach in a mathematics classroom gained positive attitudes towards the subject. Teachers should put more effort in encouraging students to use the scientific calculator for the exploration of mathematical problems. This exploratory activity in mathematics has a number of advantages in that it will encourage students to become active rather than passive learners as supported by literature review that students who are active in constructing their own understanding of mathematical concepts gained positive attitudes towards mathematics. Students who use the scientific calculator to explore possible solutions to mathematical problems improve their problem solving skills.

In order to improve the students’ Mathematical computational skills while using the scientific calculators for certain mathematical areas, it would be recommended that teachers should always use scientific calculators during
teaching in order to facilitate and enhance the use of the scientific calculators in
learning mathematics. It is also suggested that students need to have frequent
opportunity to practice using their scientific calculators, so that they become
familiar with the gadgets, with all of its features and be confident in their use if
students are to make effective use of them in a mathematics examination.
The teachers need to give students every opportunity to develop familiarity with
basic computational skills first without the use of the calculators so as to avoid
students becoming reliant on them. Teachers need to take time to teach students
how to effectively and efficiently use the calculator as well as make the students
aware of the calculator's limitations.

5.5.1 Policy Recommendations

This study suggests that a mathematics curriculum without calculator access
would only serve to discourage many students from the mathematics subject.
Therefore, this study would recommend that students be given appropriate
instructions when it's best to use the scientific calculator and when is it best to
use paper-and-pencil methods since the scientific calculator will not pose any
threat to a students' Mathematical computation ability. The calculator is there to
complement a students' Mathematical learning not to replace it (Pomerantz,
1997). Educators need to develop a clear calculator usage policy. Teachers
should implement the same policy in relation to calculator use to help avoid an
inconsistent mathematical learning experience for students of the same level
nationally.
5.5.2 Recommendations for further research

i. More research should be done to look into the long term effects of scientific calculator use on secondary school students, at how early the scientific calculators should be introduced and under what circumstances their use should be encouraged and when it should be discouraged.

ii. This study focused on the influence of calculator use on computational skills in secondary school students. Other technologies should also be explored to establish if there are other technological innovations that can help improve the computational skills in mathematics for students and improve their performance.

iii. This Study did not prescribe an effective instructional strategy for incorporating the calculator into Mathematical learning. Research could be undertaken to analyze appropriate calculator use against mindless button pushing of the calculator and to determine whether students use the calculator for mathematical computations that would be better approached by paper-and-pencil techniques or mental estimation (NCTM, 2000).

iv. Lastly, this study did not determine an appropriate time for the calculators introduction into students' education. Further research looking at the link between a students' age and calculator dependency could be undertaken to determine an appropriate timing for calculator integration into a students' education.
REFERENCES


TIMSS, (1999). *TIMSS. (Trends in International Mathematics and Science Study), Results from the TIMSS mathematics and science assessment, U.S. Department of Education Institute*


York: State University of New York College at Fredonia.
APPENDICES

APPENDIX I:

STUDENT'S QUESTIONNAIRE (SQ)

Dear student

This is a questionnaire whose aim is to get information about the influence of scientific calculators in computational skill development in the teaching and learning of mathematics in secondary schools. As a student who is studying mathematics, the information you will provide will be very useful in finding ways of improving the teaching of this subject while incorporating the scientific calculator. This information will strictly be kept confidential. You are required to respond by ticking (✓) the numerical value on the score for each item. There is no right or wrong answer.

Note: Do not tick more than one numerical value for each item in the scale.

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<tr>
<th>School</th>
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<td>Class</td>
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| Gender: | Male | Female |

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<th>School category</th>
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<tr>
<td>Boys' Boarding school</td>
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<td>Girls' Boarding school</td>
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<td>Mixed Day school</td>
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<tr>
<td>Mixed Boarding school</td>
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</tbody>
</table>
SECTION A
Student's Analysis on Availability, Accessibility and Challenges experienced while using calculators in mathematics classrooms

Key
5 Strongly Agree (SA)
4 Agree (A)
3 Undecided (U)
2 Disagree (D)
1 Strongly Disagree (SD)

<table>
<thead>
<tr>
<th>Statement</th>
<th>S</th>
<th>A</th>
<th>D</th>
<th>SD</th>
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<tbody>
<tr>
<td>1  There are adequate calculators in the class</td>
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<td>2  The calculator is in good and working condition</td>
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<td>3  I sometimes share my calculator with my classmates</td>
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<tr>
<td>4  I always use my calculator whenever solving mathematical problems</td>
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<td>5  I sometimes prefer to use paper and pencil to calculator when computing mathematical problems</td>
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<td>6  I have challenges in using a calculator due to my eyesight problems</td>
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<td>7  Over dependence on calculator makes me lazy even to basic computation problems</td>
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<td>8  I am unable to use my calculator effectively due to proper and prior training</td>
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<tr>
<td>9  I have more confidence in my ability to deal with mathematics when I have a calculator</td>
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<tr>
<td>10 Calculations in Mathematics is easier if calculators are used to solve problems</td>
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<tr>
<td>11 Calculators make mathematics fun</td>
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<tr>
<td>12 The use of a calculator confuses me</td>
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<td>13 I feel that calculators should not be used in math tests</td>
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<td></td>
<td></td>
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<tr>
<td>14 Calculator use in mathematics develops critical thinking in solving problems</td>
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<tr>
<td>15 Mathematics teacher encourage us to use calculators every time when doing a math problem</td>
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<tr>
<td>16 Mathematics teachers always use calculators while teaching</td>
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<tr>
<td>17 Mathematics teachers adequately guides us in the use of calculators</td>
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</tbody>
</table>

..............................Thanks..............................
APPENDIX II:
STUDENT’S PRE-TEST AND POST-TEST
Pre-Test Administered To Student Participants

Carry out the following tests without use of calculator. Mathematics tables may be used. Please attempt all the questions.

1. Trigonometry

Find the values of the trigometric ratios for 25°. Hence state the value of

i. $\sin 155^\circ$

ii. $\cos 205^\circ$

iii. $\tan 335^\circ$

iv. $\cos 385^\circ \sin 25^\circ$

2. Logarithms

Evaluate using logarithm tables

I. $3\log 5 + 2$

II. $\log \sin 14^\circ$

III. $\log 2 + \log 4$

IV. $\log \cos 75^\circ$

3. Squares, cubes and reciprocals

Evaluate using mathematical tables

I. $(2^2 \times 3 \times 13^2)^3$

II. $(0.1^3 \times 3.5^2 \times 7^3)^2$

III. $\frac{1}{14.64} + \frac{1}{8.73}$
Post-Test Administered To Student Participants

Carry out the following test using a calculator. Please attempt all questions.

1. **Trigonometry**

   Evaluate the following using calculators

   i. \( \sin 68^\circ \)
   
   ii. \( \cos 112^\circ \)
   
   iii. \( \tan 292^\circ \)
   
   iv. \( \cos 428^\circ \sin 68^\circ \)

2. **Logarithms**

   Use calculator to evaluate

   i. \( 5 \log 3 + 4 \)
   
   ii. \( \log \sin 89.87^\circ \)
   
   iii. \( \log 13 + \log 6 \)
   
   iv. \( \log \cos 41.82^\circ \)

3. **Squares, cubes and reciprocals**

   Calculate

   i. \( (2^3 \times 4^3 \times 6^2)^3 \)
   
   ii. \( \frac{1}{13.12} + \frac{1}{24.27} \)
APPENDIX III:

SECONDARY MATHEMATICS TEACHER'S QUESTIONNAIRE (SMTQ)

SECTION A: General information

Respond by putting a tick (✓) in all that apply

1 Gender
   male [  ]
   Female [  ]

2 Qualification
   (a) S 1 [  ]
   (b) Dip. Ed [  ]
   (c) Untrained Graduate [  ]
   (d) Trained graduate [  ]
   (e) M. ed. [  ]
   (f) M.S.C [  ]
   (g) Other (specify)---------------------------------------------------------------

3 Teaching experience
   (a) Less than one year [  ]
   (b) Between 1-4 years [  ]
   (c) Between 5-8 years [  ]
   (d) Between 9-12 years [  ]
   (e) Over 12 years [  ]

4 (i) Which class(es) do you teach or have taught mathematics mainly?
   (a) Form 1 [  ]
   (b) Form 2 [  ]
   (c) Form 3 [  ]
   (d) Form 4 [  ]

   (ii) For how long have you taught form three class in your present school?
   <1 yr [  ]
   1-3 yrs [  ]
   4-6 yrs [  ]
   >6 yrs [  ]

SECTION B: INCORPORATION OF CALCULATORS WHILE TEACHING

5. (a) Do you always use a calculator while teaching the form threes?

   b) Give reasons for your answer in (5a) above.
6(a) After incorporating calculators, how much effort do you now put in your teaching of mathematics? ________________

(b) Does the amount of effort you put into your work make a difference in mathematics performance? ________________

7 Is there a difference between students who uses a calculator and the ones who do not? If so, what difference is there?

8 How have you been influenced in your teaching of mathematics after calculators were introduced? ________________

9 In your opinion, do you think the introduction of scientific calculators is enough to equip you with more innovative mathematics teaching methodology? ________________

10 In your own opinion, do you think the incorporation of calculators has enabled you to complete the Mathematics syllabus in good time?

SECTION C:

CHALLENGES AND ATTITUDES TOWARDS CALCULATOR USE

You are required to respond by ticking (✓) the numerical value on the score for each item. There is no right or wrong answer. Note: Do not tick more than one numerical value for each item in the scale.

Key

5 Strongly Agree (SA)
4 Agree (A)
3 Undecided (U)
2 Disagree (D)
1 Strongly Disagree (SD)
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<tbody>
<tr>
<td>1</td>
<td>The calculator can improve student attitude towards mathematics</td>
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<td>A</td>
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<td>2</td>
<td>Students enjoy solving problems with calculators</td>
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<td>3</td>
<td>Calculators tend to make students lazy</td>
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<td>4</td>
<td>I always use a calculator while teaching Mathematics</td>
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<td>5</td>
<td>There is a difference in performance of students who use a calculator from those who do not</td>
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<tr>
<td>6</td>
<td>Calculators enables completion of syllabus in time</td>
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<td>7</td>
<td>Students with calculators only give answers without showing methods</td>
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<td>8</td>
<td>Use of a calculator makes students over reliant on them</td>
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<td>9</td>
<td>Calculators make students improve on time management when solving problems</td>
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<td>10</td>
<td>Calculators increases student's confidence and reduces anxiety</td>
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<td>11</td>
<td>Students prefer paper and pencil even with access to calculators</td>
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<td>12</td>
<td>There exists a clear policy for calculators use in the secondary school</td>
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</table>
APPENDIX IV

INTERVIEW QUESTIONS FOR HEADS OF DEPARTMENTS

SECTION A
i.  Do you agree with the use of calculators at secondary school level?

ii. What are the advantages to using a calculator for mathematics?

iii. Do you believe that the calculator can improve student attitudes towards mathematics?

iv. Would you have any concerns about the use of the calculator?

v. Would you agree that students rely too heavily on the calculator?

vi. Do you believe that calculators should be used in class?

vii. Do you believe that calculators should be used during examinations?

viii. What areas of the secondary mathematics curriculum rely on the calculator?

ix. What time do you spend during math instruction teaching the students how to use the calculator?
x. Has the mathematics performance improved since the introduction of calculators?

SECTION B:
HOD MATHEMATICS DOCUMENT ANALYSIS
SCHOOL: ____________________________

KCSE MATHEMATICS RESULTS ANALYSIS

<table>
<thead>
<tr>
<th>EN TRY</th>
<th>A</th>
<th>B</th>
<th>C</th>
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APPENDIX VI:

MAP KENYA SHOWING STUDY AREA
APPENDIX IX:

RESEARCH AUTHORIZATION PERMIT

CONDITIONS

1. You must report to the County Commissioner and
   the County Education Officer of the area before
   embarking on your research. Failure to do that
   may lead to the cancellation of your permit
2. Government Officers will not be interviewed
   without prior appointment.
3. No questionnaire will be used unless it has been
   approved.
4. Excavation, filming and collection of biological
   specimens are subject to further permission from
   the relevant Government Ministries.
5. You are required to submit at least two(2) hard
   copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to
   modify the conditions of this permit including
   its cancellation without notice

THIS IS TO CERTIFY THAT:

MS. FRIDAH MASESE OGETO
of KENYATTA UNIVERSITY, 866-1000
THIKA, has been permitted to conduct
research in Muranga County

on the topic: INFLUENCE OF SCIENTIFIC
CALCULATORS IN MATHEMATICAL
COMPUTATION SKILL DEVELOPMENT
AMONG LEARNERS IN PUBLIC
SECONDARY SCHOOLS IN KANDARA,
MURANGA COUNTY, KENYA

for the period ending:
31st December, 2015

Applicant's
Signature

Republic of Kenya
National Commission for Science,
Technology and Innovation
RESEARCH CLEARANCE
PERMIT

Serial No. A 4554

CONDITIONS: see back page
APPENDIX IX:

RESEARCH INTRODUCTORY LETTER

REPUBLI OF KENYA

THE PRESIDENCY
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT

Telephone: 060-2030467
Email: comuranga@gmail.com
When replying please quote

REF.NO.PUB.24/11/VOL.1/151

Fridah Masese Ogeto
Kenyatta University,
P.O. Box 43844-00100,
Nairobi.

RE: RESEARCH AUTHORIZATION

In reference to a letter Ref. No. NACOSTI/P/15/2658/5016 dated 23rd March, 2015 from the National Commission for Science, Technology and Innovation regarding the above subject, You are hereby authorized to carry out research on “Influence of scientific calculators in mathematical computation skill development among learners in public secondary schools in Kandara Sub-County,” for a period ending 6th May, 2015.

Beason M. Kamau
For: COUNTY COMMISSIONER
MURANG'A COUNTY

cc: Deputy County Commissioner,
Kandara Sub-County

1st April, 2015