

*Full Length Research Paper*

# Challenges and benefits of using scientific calculators in the teaching and learning of Mathematics in secondary school education

Jairus P. Ochanda and Francis C. Indoshi\*

Department of Educational Communication, Technology and Curriculum Studies, Maseno University, P. O. Private Bag Maseno, Kenya.

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Educational technology is recognized as an essential component of the instructional process. In particular, scientific calculator has emerged as a useful tool for teaching and learning of Mathematics in Kenya. From the year 2002, the Kenya Ministry of Education approved the use of scientific calculators in the Kenya Certificate of Secondary Education (KCSE) examination, in addition to their use in the classroom. This was intended to avoid wastage of time in solving mathematical problems and improve students' performance as before. This has raised questions as to the potential contribution of scientific calculators to the teaching and learning of Mathematics as performance did not improve with their use. It was also not clear what challenges were faced by users of this gadget. The purpose of this study therefore was to establish challenges and benefits that may result from the use of scientific calculators in the teaching and learning of Mathematics. The study was based on descriptive survey design. The study population was 44 Mathematics teachers, two Quality Assurance and Standards Officers, 24 Head teachers and 1,680 Form IV students drawn from 24 secondary schools in Emuhaya district, Kenya. Quantitative data was analyzed using descriptive statistics, that is, frequency counts, percentages and means. Qualitative data was received in verbatim form, transcribed and reported according to emergent themes.

**Key words:** Mathematics, challenges, benefits, scientific calculators.

## INTRODUCTION

Mathematics is a compulsory subject in the current 8-4-4 curriculum. It involves the process of manipulating mathematical procedures and algorithms concerning specified instructions and axioms relating to mathematical concepts under investigation. This calls on the learner to be able to think logically, present information in logical steps and proofs of theorems systematically. This is noted by the Kenya National Examination Council (KNEC) annual report which outlines the main objective of secondary school Mathematics, as that which assists in the process of producing a person who will be numerate, orderly, logical, accurate and precise in thought. S/he should be competent in appraising and using his/her mathematical skills in playing a positive role

in the development of modern society (KNEC, 1987; KNEC, 2002; ROK, 2006), yet performance in the subject has been a subject of inquiry for a number of years. Several studies have been carried out to find out the real cause of the poor performance in the subject with no tangible results. It is widely believed that performance in the subject depends largely on the effective teaching and learning process.

Ouko (2004) notes that for the last ten years, performance in national examinations indicates that, national examinations mean grade for Mathematics has been grade E which is a score below 20%. The same was noted by Aduda (2005), and Kituku (2004). A report from the KNEC newsletter found out that, the greatest challenge the learners face in the process of examination was time management. The report further noted that during examinations, candidates were not able to complete both Mathematics examination papers on time, which greatly contributes to the poor performance in the

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\*Corresponding author. E-mail: [findoshi@yahoo.com](mailto:findoshi@yahoo.com). Tel: 0722 972597, +0722972597.

**Table 1.** District Mathematics performance compared to overall district performance in Emuhaya District.

Year	2002	2003	2004	2005	2006	2007	2008
District	Math mean scores (Grades)						
Emuhaya	2.57 (D)	3.01 (D+)	2.75 (D)	2.78(D)	2.72(D)	2.17(D)	2.23(D)
Sabatia	2.88 (D)	2.91 (D)	3.05 (D+)	2.98 (D)	3.02 (D+)	3.10(D+)	2.99(D)
Vihiga	3.11 (D+)	2.96 (D)	3.02(D+)	3.46 (D+)	3.07 (D+)	3.01 (D+)	3.05 (D+)
Hamisi	2.64 (D)	2.72(D)	2.74(D)	2.73(D)	2.76 (D)	2.53(D)	2.66(D)
Average	2.80(D)	2.9 (D)	2.89 (D)	2.99(D)	2.89(D)	2.709(D)	2.73(D)

Source: District Education Office, Mbale (2008).

subject. In line with this, factors like teaching methods, attitude of both the teacher and the learner and teaching and learning resources in Mathematics have been addressed through studies, yet the root cause of this performance has not been discovered. Of much focus was the use of teaching and learning aids in the learning process.

To address this problem, there was need to introduce technology in Mathematics that could aid learners in time management in their examinations. Much of technology commonly in use in the teaching and learning process included visual aids (charts, hand-outs, pictures, photographs, cut-outs, models, flash cards, muted videos and drawings), audio aids (radio and cassette recorded sounds) and audio-visual aids (video and film clips) have been used in Mathematics, mainly to facilitate concept understanding of facts, which would otherwise be thought abstract to the learner. The afore-mentioned media in Mathematics are specifically designed to make learners understand concepts faster, than merely observing the teacher manipulate mathematical procedures and algorithms. This means that their integration in Mathematics makes teaching and learning process effective but not to aid in time management.

The aspect of time management especially when it comes to computations was addressed by the introduction of Slide rules and Mathematical tables. They were integrated in the teaching and learning process in secondary school Mathematics both as topical requirement and purely as tools to aid in computations. According to the Kenya National Examination Council (KNEC), it was reported that slide rules which were then tools to aid in computations in mathematical processes, could not be used since they were found not to give sufficient accuracy (KNEC, 1981). Learners used to spend a lot of time in computations at the expense of mathematical processes when confined to both slide rules and mathematical tables. Beginning the year 2002, a new syllabus was implemented by the Ministry of Education, Science and Technology, (ROK, 2002) which approved use of scientific calculators in Mathematics in all secondary schools nationwide. The integration of the calculators was to impact positively on the teaching and learning process by reducing drudgery of applying

arithmetic and algebraic procedures and improving manipulative skills.

According to the National Council of Teachers of Mathematics (NCTM, 1989 (a)), the use of calculators along with traditional paper-and-pencil instruction enhances the learning of basic skills. This is concurred by Roberts (1991) who noted that the integration of the calculator into the school Mathematics program should be at all grade levels in class work, homework, and evaluation" (Roberts, 1991, p.51). In addition, Roberts observes that the use of calculators should not eliminate the teaching of the basic algorithmic skills and processes of Mathematics. It should be properly integrated to reinforce the basic concepts, that are being taught and to aid in the application of these Mathematics processes in the real-world situations. The implication is that teacher-supervised activities relating to the mathematical concepts being learned are reduced. Learning therefore becomes student-centered. However, despite the adoption of scientific calculators as a tool to aid in teaching and learning Mathematics, the performance in the subject in KCSE examination in Emuhaya district from 2005 to 2007, still remain significantly low when compared with other neighboring districts, as shown in Table 1.

There is no information on scientific calculator use in Mathematics and why students continue to perform poorly in Mathematics, yet they use the scientific calculators in examination. The schools are also adequately staffed, with a teacher-student ratio of 1:38.18, which is well within the ratio recommended by the Ministry of Education (1: 40). Are scientific calculators available in schools? Do students use scientific calculators as tools to aid them in Mathematics processes and computations? The poor performance in Mathematics in Emuhaya District reveals that, there is a problem with the teaching and learning of Mathematics despite the introduction of scientific calculators as a teaching and learning resource. There is need therefore to understand the challenges encountered and benefits that schools could take advantage of this new technology. This study was therefore designed to establish the benefits and challenges in the use of scientific calculators in the teaching and learning of Mathematics in Emuhaya

District, Kenya. The specific objectives of the study were:

- i) Assess benefits that may come from the use of scientific calculators for students and teachers in Mathematics in secondary schools.
- ii) Assess challenges experienced by teachers and learners in using scientific calculators in Mathematics in secondary schools.

### **Benefits of scientific calculator use in Mathematics**

Several studies (Hunter, 1994; McCoy, 1996; Azita, 1999) on the use of instructional technology such as calculators have shown that, this technology helps in improving spatial visualization skills, critical thinking ability, understanding of connections among graphical, tabular, numerical, and algebraic representations and improvement of students' confidence in Mathematics. These are opportunities which when exploited will benefit the learner. These benefits could arise from teaching methods and approaches in the teaching and learning process.

Activities selected in the teaching and learning of Mathematics using scientific calculators must be in line with the objectives of the lesson. The activities must also involve plenty of student activity and acquisition of skills, an enabling environment should also be created to give the learner an opportunity to interact freely with the calculator and fellow learners through questions. This is arrived at when the teacher adequately prepares for the teaching sessions, in addition to availing scientific calculators to the learners. Ambuko (2008) notes that availability of various media resources and their advantage in classroom instruction has necessitated the integration of such media in the teaching and learning process.

He further notes that greater benefits can be achieved from the use of multi-media approach when all senses are involved in the learning process. Several research studies have documented the benefits of calculator use in the Mathematics classroom (Campbell and Stewart, 1993; Carlson, 1995; Dunham, 1993; 1996; Graham and Thomas, 2000; Harvey et al., 1995; Hembree and Dessart, 1986; Hennessy et al., 2001; Quesada and Maxwell, 1994). The benefits could arise from the availability and proper use of scientific calculators in the learning process.

### **Accessibility to scientific calculators**

Briggs (1977) postulates that, the use of media during instruction process motivates the learners by capturing their attention and stimulating interest in the subject. Media also integrates learners vicariously but meaningfully in the learning experience, explains and

illustrates subject content and performance skills in addition to providing opportunities for self-analysis of individual performance and behavior.

According to baseline survey by SMASSE, it was revealed that lack of enough teaching and learning resources like laboratories, and textbooks made it difficult for the teacher to complete the syllabus on time and for those who did, students were not well prepared in knowledge and creativity. This meant that the learners could not perform in the national examinations. The study is relevant to the current study in that, it looked at the accessibility to various learning resources by the learners, while this study looked specifically at the accessibility to scientific calculators by the learners in Mathematics and its impact to the teaching and learning of Mathematics.

### **Teaching methods**

Since technology is recognized as an essential component of the instructional process, the advent of calculator technology has influenced the teaching and learning of Mathematics in a profound way (Dunham and Dick, 1994; Demana and Waits, 1990; Fey and Good, 1985). As noted by Ambuko (2008), greater benefits can be achieved from the use of multi-media approach to learning, since all senses are involved. Ambuko further notes that these teaching and learning resources and their advantages in classroom instruction have necessitated the integration of such media in the teaching and learning process.

Whereas study by Ambuko looked at selection and use of media in the teaching and learning of Kiswahili in secondary schools in Emuhaya District, this study looked at the benefits that may result from the use of scientific calculators in the teaching and learning of Mathematics in secondary schools in Emuhaya District. Ambuko's study employed observation schedule and document analysis, as part of his instruments of data collection, this study only used questionnaires and interview schedules in collecting data for the study.

### **Attitudes of learner and teacher**

When students perceive learning to be interesting, fun, personally meaningful, and relevant, the context supports and encourages personal control, motivation to learn which results in self-regulation of the learning process occurring naturally. Learning activities and experiences that students find interesting and stimulating are usually inherently motivating. This means that, when students' interests in prescribed learning have been aroused, there is usually little need for other incentives or reinforcers. This is confirmed by Briggs (1977) who notes that, Media contributes to attitude formation and the development of

appreciations.

A study carried out by Ruth (2000) in the use of calculators in the teaching and learning of Mathematics notes that, participants (5 to 14 years old) were able to develop a wide variety of resources, which make use of calculators, and try them out in their own classrooms. Findings highlight the potential value of hand-held technology in increasing motivation, investigating pattern, improving mental skills, developing number sense and estimation skills, building number concepts (particularly place value) and tackling 'real life' Mathematics.

According to Dunham (1995), calculator use results in more positive feelings and better attitudes about Mathematics for both students and teachers. Both studies involved both students and teachers in finding about their attitudes towards Mathematics, but the current study sought to find out, if the use of scientific calculators in Mathematics improves attitudes of learners and teachers towards the teaching and learning process in Mathematics in Emuhaya District. The current study used both questionnaire and interview schedules to achieve this, while the study by Dunham did not. The study by Ruth conducted investigations on age brackets of 5 to 14 year olds while this study was focused on form four students (above the age bracket of between 5 and 14 years).

### **Challenges in the use of scientific calculators in Mathematics**

Although, a study by Ambuko (2008) points out that, availability of various media resources and their advantages in classroom instruction has necessitated the integration of such media in the teaching and learning process, these media may present challenges to the teachers and learners in the learning process, such as accessibility, negative attitudes and lack of training. Therefore, challenges may arise from the methods used in the teaching and learning of Mathematics using a scientific calculator. Challenges may also arise from a situation where a learner does not access a scientific calculator in the teaching and learning process. This may affect attitude of both the teacher and the learner towards the use of scientific calculators in Mathematics.

### **Accessibility**

To effectively use calculator technology in a Mathematics learning process, each learner in the class should have access to a calculator during learning sessions. The calculators can be provided to the learners through a system that ensures all learners have the gadget. Whereas the study by Burrill was conducted to compare the availability of scientific calculators between the rural and urban schools, this study sought to establish the extent to which learners accessed scientific calculators

during the teaching and learning of Mathematics in secondary schools in Emuhaya District.

### **Teaching methods**

Balozi and Njunge (2004) carried out a study on teaching methods. The study established that, most lessons were conducted through lecture method, with little or no participation in practical skills, this led to poor results in KCSE examination. The study differed from their study in that, it looked at whether teaching methods presented challenges in the use of scientific calculators in the teaching and learning of Mathematics. Besides, Balozi and Njunge focused on observation while the current study used interviews schedule and questionnaires as a source of information for the study.

### **Attitudes**

Farrant (1980) notes that educational change, whether caused by curriculum development, increased investment or adoption of innovative practices almost always places the teacher in some new role. This necessitates the teacher to be prepared for the new function. A study by Ouko (2004) on teachers' attitudes towards teaching and learning of Mathematics in secondary schools in Kisumu District established that, teachers had negative attitudes towards teaching Mathematics and science. The study, although relevant to this study used systematic sampling in determining the study sample, whereas this study employed random and saturated sampling in determining the study samples. Besides, this study was carried out in Emuhaya District.

### **Lack of training and in-sets**

According to Indoshi (1999), any profession including teaching requires the practitioner to continue his education throughout his entire professional life. This includes attendance of courses frequently. This is because there is need to help the teacher to gain knowledge and competences, he must master if he is to avoid lapsing into rapid professional obsolescence. According to Wild (1996), an assumption is being made that the teachers need to know how to use the tools of technology without first knowing why they need the tools, and what they are going to do in the classroom with the tools. This means that, a majority of teachers do not know how to use scientific calculators during the teaching and learning process. Taylor (1994) also notes that, teachers who have no interest in using technology, need some level of incentive as well as support from administrators.

Olson (1992) also notes that, schools often overlook

**Table 2.** Sample frame.

<b>Respondents</b>	<b>Total number</b>	<b>Number selected</b>	<b>Percentage (%)</b>
Students	1680	504	30.00
Mathematics teachers	44	42	95.45

Source: District Education Office, Emuhaya (2008).

the importance of providing professional development activities that will allow teachers to understand why they need the tools, what they will do with the tools, and how to use the tools. This makes most classroom teachers today spend the majority of their time on the very same manipulations using paper and pencil techniques. Burrill concurred with this finding and notes that, successful incorporation of technology into the secondary school Mathematics classroom has so far been elusive (Burrill, 1992). The study hence looked at the challenges the learners may face in the use of this resource, in the teaching and learning process.

## METHODOLOGY

### Research design

The study was based on descriptive survey design. Descriptive survey design is based on the premise that, problems can be solved and practices improved through objective thorough observation, analysis and description. It involves obtaining information or data collection by getting responses from persons in a wide geographical area through questionnaires and interview schedules, in order to test hypotheses or to answer research questions of a given study (Thomas and Nelson, 1996). This design was chosen for this study for its appropriateness in educational fact finding which yields accurate information; this study aimed at collecting accurate information and characteristics that were observable in Mathematics teaching and learning using scientific calculators in secondary schools in Emuhaya District.

### Area of study

The study was carried out in all the 24 public secondary schools in Emuhaya District, Kenya. Emuhaya District is one of the 16 districts in Western province. The district was carved from Vihiga District in 2007. It borders Butere District to the North, Vihiga District to the East, Kisumu District to the South and Siaya District to the West. The district is densely populated and is divided into two administrative divisions; Luanda and Emuhaya Divisions. The district also experiences very high poverty levels that stand at 56.7% of the total population (Republic of Kenya, 2002).

Furthermore, 52.3% of the households of the district live below poverty level. The district has in the recent past recorded improved performance in other subjects in the K.C.S.E. examinations unlike Mathematics. The schools have fairly improved educational infrastructure funded mostly through the Constituency Development Fund (CDF), professionally trained teachers, satisfactory physical facilities, and secure environment. The district lies on the latitude 0° and between longitude, 34° 33 E and 34° 40 E. The area of study was chosen because the performance in Mathematics for the district has been experiencing a downward trend, as compared to other neighboring districts. In addition, the teacher-student ratio for

Mathematics is 1:38.18 which is within the Ministry's recommended value of 1: 40.

### Study population

The study population consisted of 1680 form four students, 44 Mathematics teachers, 24 Head teachers in all the 24 public secondary schools and 2 Quality Assurance and Standards Officers in Emuhaya District. The study chose form four students because this is a class where both mathematical tables and calculators are used in computations. The study also settled on Mathematics teachers because they are the ones who use the calculator in the teaching process. It also settled on Quality Assurance and Standards Officers because they are the ones who check the effectiveness of the teaching and learning process and whether the implementation of the curriculum in class is taking place.

### Sample and sampling techniques

Simple random sampling procedure was used to select a sample of 504 students from 1,680 form four students, representing 30% of the study population. Simple random sampling technique was chosen because it eliminates chances of biasness in selecting of study samples. Saturated sampling was used to select 42 Mathematics teachers, 22 Head teachers and 2 QASOs in the 22 schools. Saturated sampling is a non-probability sampling procedure in which all the members of the target population are selected because they are too few to make a sample out of them (Borg and Gall, 1996). In total, 575 respondents were selected for the study. The study population and sample are shown in Table 2.

### Instruments of data collection

Questionnaire and interview schedules were used to collect data from schools. The students' questionnaire consisted of two sections. Section A consisted of general information, namely, the name of the school, class, individual scores in Mathematics in end of term one examinations and the opinion on the way Mathematics is taught in the schools, while section B consisted of question items with open ended questions that provided the learner with an opportunity to express their opinion on issues projected in each section of the questionnaire.

Mathematics Teachers' Interview Schedule consisted of two sections. Section A consists of general information about the teacher and the school, while section B had objective questions for responses designed for both YES or NO (categorical responses) and open-ended questions that require responses recorded word for word by the interviewer (Merriam, 1988). The Teachers' Interview Schedule was designed to explore; teacher-learner interaction, teachers' view on the learner behavior during the use of calculators, teacher-calculator interaction, learner-calculator interaction. Mathematics teachers' Questionnaire consisted of two sections. In section A, general information about the teacher was to be given about the teacher's workload. In section B, specific information about using calculators was to be given on classroom interaction

**Table 3.** Benefits arising from the use of scientific calculator according to learners (n=504).

<b>Benefits from the use of scientific calculator in Mathematics</b>	<b>Frequency</b>	<b>Percentage (%)</b>
Makes Mathematics concepts well understood	102	20.24
Increase the mastery of computing skills and the amount of calculations	147	29.17
Display accurate answers on the screen and used to confirm answers	144	28.57
Motivate learners to want to work more	96	19.05
Convenient for confidential working	15	2.97
Total	504	100

with the learner during the use of the calculator, teacher approach, learner behavior and use of the scientific calculator in the teaching and learning process.

### Reliability and validity

Reliability measures the degree to which a particular measuring procedure gives similar results over a number of repeated trials (Orodho, 2004: 41). For reliability of instruments of research to be achieved, a pilot study was conducted out in two public secondary schools involving two teachers selected by using simple random sampling technique (10% of study population). The schools were not part of the final study. This was to test the reliability of the questionnaires and interview schedule. The inadequacies, inconsistencies and weaknesses in the instruments were corrected before they were finally used in the field.

According to Mugenda and Mugenda (1999) validity is the degree to which the empirical measure or several measures of concepts accurately measure the concepts. For validity of the instruments to be ensured, three experts from the Department of Educational, Communication Technology and Curriculum Studies, Maseno University examined the instruments, advised and gave recommendations on face validity. Improvements were made according to the recommendations suggested by the experts before the instruments were finally used in the field.

### Data collection procedure

The researcher sought permission from the Ministry of Education through the Director of the School of Graduate Studies (DSGS) Maseno University to collect data. A copy of the permission from the ministry was availed to the DEO, Emuhaya District; and the area Education officers in charge of the two divisions. When the permit was obtained, the researcher contacted head teachers of selected schools in writing to inform them of the researcher's intention to visit their schools for data collection. The researcher then visited the schools to administer questionnaires to the respective respondents; students, teacher and head teachers and collected them the same day for each school sampled. The researcher also contacted face-to-face interviews with subject teachers and the Quality Assurance and Standards Officers (QASOs), concerning the items enlisted in the interview schedule on separate days.

### Methods of data analysis

Two types of data were collected; Quantitative data and Qualitative data. Quantitative which was data collected using students' questionnaires was analyzed according to research questions by the use of descriptive statistics. This involved coding of data, for responses to the closed-ended questions and analyzing the data

using the Statistical Package for Social Sciences (SPSS) program to yield frequencies, means and percentages (Thomas and Nelson, 1996). Responses to the open-ended questions, which formed the qualitative data, were organized, categorized and reported in emergent themes.

## RESULTS AND DISCUSSION

### Benefits from the use of scientific calculators in Mathematics

The study sought to analyze the benefits to the learners, that may result from the use of scientific calculators in a Mathematics class. According to responses given by the learners, the following statistics were given as the benefits of using scientific calculators in Mathematics education as given in Table 3. The results in Table 3 were also in line with the findings from Mathematics teachers under the study, who found out the benefits arising from the use of scientific calculator in Mathematics education. The study established that, since calculators are just tools for performing computations, they have great potential as instructional aids for the development of Mathematics concepts and understanding, especially when learners are proficient in their use.

An active participation in the lesson helps maintain it over time. When solving problems, it was reported that students often involved themselves in creative processes. The learners may search for alternative methods of solving a problem, hence avoiding a lot of paper work. Besides, they can create and recognize patterns from a given set up of mathematical problems, through association of related ideas. Learners can also experiment with different ways of communicating Mathematics ideas during discussion time with other learners. Lastly, learners can also create personal hypotheses and generate problems relevant to what they have learned.

From the findings of this study, it is established that scientific calculators provide learners with opportunities which make them benefit from the use of scientific calculators in the learning of Mathematics. Learners are able to increase the volume of calculations in a given time because calculators make computation faster. Other than this benefit, scientific calculators were seen as simple tools which the learner can use to save on time,

**Table 4.** Challenges in the use of scientific calculators in Mathematics (n=504).

<b>Challenges in using scientific calculators</b>	<b>Frequency (f)</b>	<b>Percentage (%)</b>
In-ability to use scientific calculators properly in Mathematics under topical requirement	330	65.47
De-linking the mind from basic computation abilities	76	15.08
Accessibility to scientific calculators	27	5.36
Learners with sight problems	71	14.09
Total	504	100

especially where large volumes of calculations are involved. Therefore, the calculators should be used frequently for the learner to exploit the benefits that come with their use, such as improved attitude towards the subject and time management due to the fact that, calculators are faster to use in computations as compared to the traditional pen-paper technique of computation. The findings of the study concur with the findings of a study by Dunham (1995), who noted that scientific calculator use, results in more positive feelings and better attitudes about Mathematics for both teachers and learners.

Similar findings were noted by Smith (1977). In this study, Smith conducted a meta-analysis that extended the results of Hembree and Dessert (1993). Smith analyzed twenty four research studies conducted from 1984 to 1995. As in Hembree and Dessert's study, test results of students using calculators were compared to those of students not using calculators. Smith's study showed that, the calculator had a positive effect on increasing conceptual knowledge at all levels from the third grade to the twelfth grade. This was noted from the results of this study for those learners who are proficient in the use of scientific calculators in the learning of Mathematics with the calculator.

### **Challenges in the use of scientific calculators**

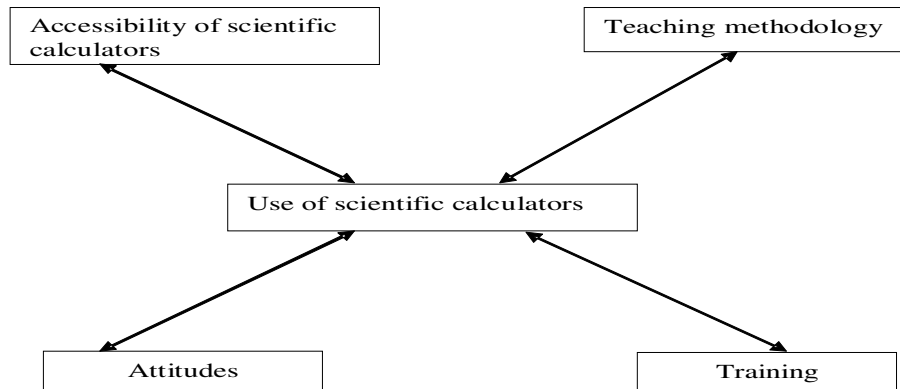
Current Mathematics practice in Kenya is text-book driven. This means that it is teacher- centered and consists mainly of transmission of knowledge from the teacher to students. This completely ignores the fact that, students are of varied abilities with different backgrounds and fails to take into account individual differences. This results in the learners becoming passive recipients of knowledge and consequently develops negative attitudes towards the subject. Thus, Mathematics is reduced to memorization of procedures, facts, formulae and algorithms. In line with this, the study sought to find out the challenges learners face in the process of using scientific calculators in a Mathematics class during learning sessions and in Mathematics examinations time. The following responses on challenges were reported as shown in Table 4.

From the findings in Table 4, the study established that

most of the challenges facing the learners in the use of scientific calculators are emanating from inability of the learner to use scientific calculator in Mathematics and learners not able to access a scientific calculator during the teaching and learning process. A majority of respondents (65.47%) reported that, they were unable to use scientific calculators effectively. It was established that learners lacked hands-on training opportunities, when it came to calculator use in Mathematics. This was because teachers do not teach learners how to use scientific calculators well in advance, before concepts from a particular topic are taught. This problem was attributed to the teachers' level of preparedness. This concurs with a study by Kituku (2004) on lesson planning by teachers in secondary schools. The study found out that, lack of teacher's preparedness leads to ineffective content delivery, which may in turn lead to in-effective teaching and learning process.

Therefore, SMASSE initiative such as ASEI movement had been introduced to help the teacher reflect on their teaching methods and acquire skills for effective teaching, that could lead to efficient learning. This was to be accompanied with in-service on the planning under PDSI approach where focus shifted from teacher to learner. The initiative had its strengths, since it recognized that meaningful learning takes place in an environment in which students are actively engaged in focused and sequenced activities for acquisition of knowledge and skills. The Ministry of Education also has it that, with lack of adequate preparation and resources, teachers may not embrace the use of technology. Therefore, teachers' fears about technology need to be understood and addressed. Due to this challenge, learners tend to develop negative attitude toward calculator use.

A minority (5.36%) reported that, they accessed scientific calculators during the teaching and learning of Mathematics. This left a majority of the learners not having scientific calculators during the teaching and learning sessions in Mathematics. A situation where many learners do not access a calculator, yet the calculator is a topical requirement in some areas of evaluation, leaves the learner with no option but to borrow from others in the classroom. This does not lead to good time management. This could be a reason why performance in the subject has persistently been affected



**Figure 1.** Challenges and Benefits in Using Scientific Calculators in Mathematics in Secondary School Education

negatively, since availability of this resource determines whether a learner will be able to use it effectively in computations or not. Physical disabilities such as sight problem were also identified as a challenge for the learners affected. The learners identified reported that, they took a long time locating where right keys were at the expense of time. This led to poor time management during the learning sessions as well as during examination. Learners with special needs (SNE) need to be catered for in the event of integrating technology in Mathematics education. Kochung' (M.O.E, 2003), reports that learners with SNE require more materials for their education than their non-disabled peers both at classroom and at individual level.

Over-dependency on scientific calculators during computations was reported as one factor, that makes learners de-link their minds from basic computation capabilities. This makes learners lazy in computation in the absence of the calculators. It is hoped that scientific calculators are used as a tool in problem solving... sort of like a "fast pencil." In addition, it is expected that a calculator is used for complex computations but not for basic facts! a calculator to be used to develop number concepts and skills, while at the same time, using a calculator in testing situations when not assessing computational proficiency. In general, a calculator should be used to help teach Mathematics better, not to replace the teaching of Mathematics.

## CONCLUSIONS AND IMPLICATION FOR POLICY AND PRACTICE

### Conclusions

The study concludes that, calculator use can benefit the learner and the teacher. This is observed when the learners are actively involved in the learning process with minimum teacher supervision and direction. The benefits include making Mathematics concepts well understood,

increasing the mastery of computing skills and amount of calculations, displaying accurate answers on the screen and using it to confirm answers, motivate learners to want to work more, and are convenient for confidential working for those who know how to use the calculator. These benefits should be exploited to increase the number of learners who are proficient in the use of the calculator to make teaching and learning more effective and learner-centred. This will go towards improving performance in the subject.

### Challenges faced by learners in the use of scientific calculators in a Mathematics class

The study established that, there are various challenges linked to scientific calculator use in Mathematics in Mathematics class. These included provision of scientific calculators to the learners. On provision, it was established that parents and guardians were to provide learners with scientific calculators. This was a problem because the study established that, most learners did not have scientific calculators because of poverty. In addition, since most learners did not access scientific calculators frequently, they were unable to use scientific calculators effectively in Mathematics, especially when provided with one during examination time.

In addition, there were learners with sight problems who were not able to use the calculators effectively. These learners were grouped as those with special needs, under an integrated system of learning. Time management for this group of learners was a real problem. These challenges should be addressed to make the teaching and learning of Mathematics effective.

### Implications for policy and practice

The research was conceptualized on the benefits and challenges in the use of scientific calculators in the



teaching and learning of Mathematics. These implications are shown in Figure 1. The benefits included making Mathematics concepts well understood, increasing the mastery of computing skills and amount of calculations, as well as using it to confirm answers, displaying accurate answers on the screen, motivating learners to want to work more and the calculator being convenient for confidential working. The challenges include inability to use scientific calculators properly in Mathematics under topical requirements, de-linking the mind of the learner from basic computation capabilities, accessibility to scientific calculators during Mathematics learning process and sight problem in some of the learners.

### Availability and accessibility of scientific calculators

- i) The Ministry of Education should fund the purchase of scientific calculators for all learners at secondary school level, to ensure every learner accesses a scientific calculator during the learning sessions and during examination times. This should be carried out under similar scheme of Free Secondary Education (FSE) currently underway. This will provide a calculator- learner ratio of 1:1. This will make content delivery effective.
- ii) District policy on calculator technology acquisition use and integration in Mathematics should be formulated.

### Benefits from the use of scientific calculator

- i) The manufacturers through the Ministry of Education and the Kenya Institute of Education (KIE) to provide a calculator that caters for learners with sight problems.
- ii) Schools should set up Mathematics laboratory (Technology in Education Centre) that pays special attention to practical sessions in Mathematics, to promote participatory and collaborative learning in the use of scientific calculators in Mathematics. This will reduce the role of the teacher to a facilitator rather than a provider of knowledge.

### Challenges faced by learners when using scientific calculator

- i) Refresher courses on the use of calculator technology to be regular at the district level, to upraise teachers' knowledge and skills on calculator use while at the same time developing positive attitude, toward calculator technology integration in Mathematics.
- ii) The government should set out guidelines to suppliers on the quality of calculator expected to be supplied to the learners through the re-introduction of the Kenya School Equipment Scheme (KSES).
- iii) The Ministry of Education should source funds from development partners and donors in the education sector, to be able to purchase calculators for every

learner, as well as formulating a policy on provision of scientific calculators to the learners, to eliminate problems associated with accessibility and use of scientific calculators in Mathematics in secondary schools in Kenya, to ensure equitable accessibility to calculators by the learners.

- iv) The Ministry of Education should organize seminars that concern calculator use in Mathematics and other related disciplines across the secondary school curriculum for teachers. This can be achieved through SMASSE.
- v) Do away with topical requirement of scientific calculator, since this tends to make teachers and learners spend a lot of time mastering calculator manipulative skills, instead of using calculators as tools to aid computations.
- vi) The manufacturers through the Ministry of Education to provide a calculator that caters for learners with sight problems; a calculator made with ear-phones could be ideal where sounds will be produced upon pressing the relevant keys (talking calculators).
- vii) More materials on calculator technology to be supplied to schools as teaching and learning aids, to cater for individual differences amongst learners. A special panel set up to design and produce materials related to calculator technology use, such as texts and charts to be accessed by the learners in specially designed places like Mathematics labs, classroom walls displays.
- viii) The calculator-learner ratio to be 1:1; so as to ensure every learner accesses a calculator during teaching and learning sessions and examination times through subsidized schemes, such as the free secondary education by the government.

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