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Challenges in the use of Scientific Calculators in the Teaching and Learning Mathematics in Secondary School Education

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ABSTRACT

Scientific calculators have emerged as useful tools for mathematical procedures and manipulations. From the year 2002, the ministry of education approved the use scientific calculators in the Kenya Certificate of Secondary Education (KCSE) examination and in the classroom, as a tool to aid in computations. This was intended to avoid wastage of time in solving mathematical problems and improve students' performance. This has raised questions as to the potential contribution of scientific calculators to the teaching and learning of mathematics (benefits) in secondary schools. It is also not clear what challenges may be faced by teachers and learners when using scientific calculators in mathematics. The purpose of this study therefore was to establish challenges presented to the learners in the use of scientific calculators in learning of mathematics in public secondary schools in Emuhaya District, Kenya. The study was based on descriptive survey design. The study population consisted of 44 mathematics teachers, two Quality Assurance and Standards Officers in the district, 24 Head teachers and 1680 form 4 students in all 24 secondary schools in the district. The study was carried out in Emuhaya district because the district is well staffed in terms of teaching force with a teacher- learner ratio of 1:38.1 as compared to the government recommended ratio of 1:40, yet the performance in mathematics remains low. Quantitative data was analyzed using descriptive statistics, i.e., frequency counts, percentages and means. Qualitative data was received in verbatim form, transcribed and reported according to emergent themes. Data analyzed was presented using tables and graphs.

Keywords: *Mathematics, Scientific calculators, utilization, secondary schools, Emuhaya District, Kenya*

1. INTRODUCTION AND BACKGROUND INFORMATION

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.

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**.** Where as study by Ambuko looked at selection and use of media in the teaching and learning 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.

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 & Dick, 1994; Demana & Waits, 1990; Fey & Good, 1985).

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- 14years 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 teacher 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- 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 use of scientific calculator 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.

Where as 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, where as 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 obsolesce.

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 don't 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 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.

2. 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, & Nelson., 1996). This design was chosen for this study for it's 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 curved 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.

Emuhaya 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 0^0 and between longitude, $34^0\,33'$ E and $34^0\,40'$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 & Gall, 1996). In total, 575 respondents were selected for the study. The study population and sample are shown in Table 1.

Table 1: Sample Frame

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

Source: *District Education Office, Emuhaya (2008)*

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 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, P41). 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. The copy of 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, & Nelson, 1996). Responses to the open-ended questions, which formed the qualitative data, were organized, categorized and reported in emergent themes.

3. RESULTS AND DISCUSSIONS

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 2.

Table 4: Challenges in the use of scientific calculators in mathematics (n=504)

Challenges in using scientific calculators	Frequency (f)	Percentage (%)
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**

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 in-ability of the learner to use the scientific calculator in mathematics. This is because most learners were 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 learners lacked hands-on training opportunities when it came to calculator use in mathematics. In addition it was established that 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 don't 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 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 there minds from basic computation capabilities. This makes learners lazy in computation in the absence of the calculators. It is hoped that scientific calculator 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.

4. CONCLUSIONS AND IMPLICATION FOR POLICY AND PRACTICE

Conclusions

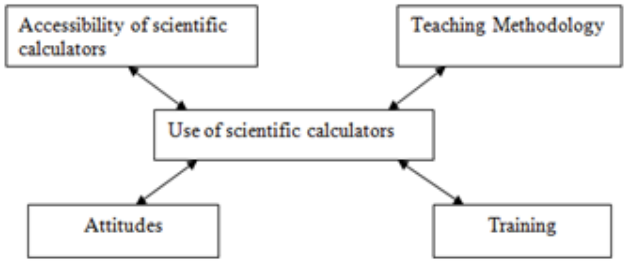
The study concludes that calculator use can benefit the learner and the teacher. This is observed when the learners are actively involved in the learning process with minimum teacher supervision and direction. The benefits include; making mathematics concepts well understood, increasing the mastery of 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 in order 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 so as 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; in-ability 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

The study sought to find out availability of scientific calculators among students in mathematics

Since a majority did not have scientific calculators during the learning sessions, the lessons could not have been effectively covered. When it comes to examinations, some compulsory questions in mathematics demand the use of a scientific calculator in mathematical manipulations and computational procedures, thus with very few learners accessing a scientific calculator in the teaching and learning process, lesson objectives could hardly be achieved on time. This could be a contributing factor to the poor performance in the subject. These findings concur with the study carried out by Chitwa and Njunge (2004) which revealed that generally, lack of teaching and learning resources in secondary schools contribute to in-effective learning process which eventually results in poor performance in the subject. This is also noted by a study by Ouko (2004) which had sought to find out the availability of learning resources in public secondary schools in Kisumu District in relation to performance classes. The responses of learners are shown in Figure 2.

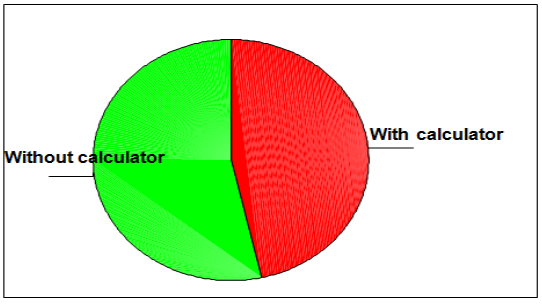


Figure 2: Availability of scientific calculators in a mathematics class

From Figure 2, 46.43 % of the students (234 respondents) had scientific calculators 53.57% of the learners (270 respondents) did not have scientific calculators during mathematics learning sessions. The study had the following suggestions:

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 examinations 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

Learners who did not have scientific calculators were asked to state reasons for this. Their responses are summarized in Figure 3. However, besides poverty, the study also found out that ignorance was also cited as reason why the learners did not have calculators since 5.29% of the learners (14 respondents) reported that their parents deliberately refused to buy them scientific calculators claiming that the calculators were not necessary for them to pass highly in mathematics, while 11% (32 respondents) of learners reported that parents argued that since the government pledged to provide free secondary education to all, then it is its duty to provide the scientific calculators free of charge to the learners. A small number of respondents (9%) reported that they had lent their calculators to their friends from other classes (See Figure 3). This meant that those who borrowed from others did not have one of their own. These findings concur with those of Question item 1 part (a) of the Teacher interview schedule (MTIS) which established that 41.07 % (207 respondents) of learners had access to scientific calculators while 58.93 % (297 respondents) of the learners did not have access to scientific calculators during mathematics learning sessions.

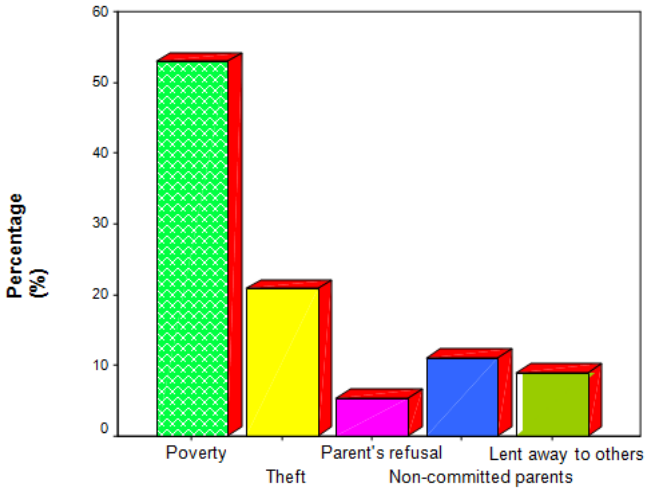


Figure 3: Reasons for not having scientific calculators in mathematics class according to learners

From Figure 3, it is shown that a majority (52.90%) reported that their parents were not able to purchase the scientific calculator for them because they did not have the money, while 20.81 % of the learners (57 respondents) reported that their calculators were missing because they were stolen from them while in their classes.

Recommendations for further action

In view of the research findings stated above, the researcher recommended that:

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 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 in order to ensure equitable accessibility to calculators by the learners.
iv. The ministry of education should organize seminars and insets 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 spent 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. Lastly, 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.

REFERENCES

Ambuko, B.S. (2008). Media selection and use in teaching and learning Kiswahili. Unpublished Thesis M.Ed Thesis, Maseno University

Azita, M. (1999).computers and school mathematics reform: implications for mathematics and science teaching. Journal of Computers in Mathematics and Science Teaching. Vol.18 (1)31-48.

Balozi, C. & Njunge ,J.(2004, August 2nd).Trends in Teaching approaches and methods in Science and Mathematics Education "SMASSE project.

Borg, R.W. & Gall, J.P., (1996). Educational Research: An Introduction. New York:Longman Publishers.

Briggs L. (1977). Instructional Design: Principles and Applications. New York: Englewood Cliffs.

Burrill, G. (1992). The Graphing Calculator: A Tool For Change.

Campbell, P., & Stewart, E.L. (1993). Calculators And Computers. In R. Jensen (Ed.), Early Childhood Mathematics, NCTM Research Interpretation Project pp. 251-268. New York: Macmillan Publishing Company

Carlson, M. P. (1995). A Successful Transition To A Calculator Integrated College Algebra Curriculum: Clues, Surveys, And Trends. In P. Bogack (Managing Ed.), E. D. Fife, & L. Husch (Eds.), Proceedings Of The Seventh Annual International Conference on Technology in Collegiate Mathematics (pp. 73-77). Reading, MA: Addison-Wesley Publishing Group.

Demana, F., & Waits, B. K. (1990). Implementing The Standards: The Role of Technology in Teaching Mathematics, Mathematics Teacher.vol 83, 27-31.
Dunham, P. H. (1993). Does Using Calculators Work?

The Jury Is Almost In. UME Trends, 5(2), 8-9 (1995). 'Calculator Use and Gender Issues', Association for Women in Mathematics Newsletter vol. 25 (2), 16-18.

Looking For Trends: What's New In Graphing Calculator Research? In P. Bogack (Managing Ed.), E. D. Fife, & L. Husch (Eds.) Proceedings of The Eighth Annual International Conference on Technology In Collegiate Mathematics pp. 120-124. Reading, MA: Addison Wesley Publishing Company

Farrant, J.S. (1986). Principles And Practice Of Education. Singapore: Longman Publishers Limited

Graham, A. T., & Thomas, M. O. J. (2000). Building a Versatile Understanding of Algebraic variables With a Graphic Calculator. Educational Studies in Mathematics, 41(3), 265-282.

Harvey, *et al,* (1995). The Influence of Technology On The Teaching and Learning of Algebra. Journal of Mathematical Behavior, 14, 75-109.

Hembree, R. & D. J. Dessart, (1986). Effects of Hand-Held Calculators in Pre-College Mathematics Education. 17(2): 83-99

Hennessey, S., et al (2001). The Role Of The Graphic Calculator In Mediating Graphing Activity. Education In Science and Technology, Vol 32, 267-290

Hunter, P.E. (1994). Mathematics As Author. Strategies For Developing Successful Classroom .In Carey D. et al. Indoshi F.C (1999).

Kituku, G.K. (2004 September 1st). Asei Lesson Plan. SMASSE Project p2

McCoy, L. P. (1996). Computer-Based Mathematics Learning. Journal of Research on Computing in Education, vol28 (4) 438-455.

Olson, L. (1992). Use of Technology In Schools: Still Elusive. The Education Digest, 57 (9), 20 - 22.

Ouko, C. (2004, August)."SMASSE: An Initiative To Improve Mathematics And Science Learning In Secondary Schools" Teachers' Image vol.9p23.

Quesada, A. R., & Maxwell, M. E. (1994). The Effects of Using Graphing Calculators to Enhance College Students' Performance in Pre-Calculus. Educational Studies in Mathematics, 27, 205-215.

ROK, (2002). Secondary Education Syllabus: Volume Four Nairobi: K. I. E.

(2007).Secondary School Mathematics Hand Book. Nairobi: KIE

Ruth, F. 'It is not calculators but how they are used...', Chapter 1 in Way, J. and Beardon, T.(eds) ICT and Primary Mathematics (Open University Press). Retrieved @NRICH website http://nrich.maths.org/conference/reports/forrester.html, July 2000.

SMASSE Project (1998). Baseline Studies. SMASSE Project.

SMASSE Project (2008). Cycle 1 of Vihiga/ Hamisi/ Emuhaya/ Districts INSET-2008.

Taylor, P.S. (1994). Teaching and Learning with Technology at the University of West Florida. Technology in Education Quarterly, 6 (3), 63 - 72.

Thomas, J.R. & Nelson J.K., (1996). Research Methods In Physical Activity.

Edward Brothers. Champaign, IL 61825-5076

Wild, M. (1996). Technology Refusal: Rationalizing the Failure of Student and Beginning Teachers to use Computers. British Journal of Educational Technology, 27 (2), 134 - 143.