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Full Length Research

Effectiveness of Scientific Calculators on Secondary School Students' Attitude Development in Mathematics

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There is poor performance in mathematics among secondary school students in Kenya. In an effort to improve performance in the subject, there has been introduction of various devices aimed at helping learners to get solutions to mathematical problems starting from counting sticks, abacus, slide rule, mathematical tables and recently scientific calculators. Unfortunately, there is no tangible evidence to show that scientific calculators will solve the problem in mathematics. The purpose of this study was to investigate the effect of using scientific calculators in Mathematics instruction and establish if they had any effect on students' attitude. An experimental research design was adopted entailing the pre – test post-test equivalent groups design. The population was drawn from the form three students selected from public secondary schools in Mumias Sub County. The findings in the study showed that the use of scientific calculators was superior to mathematical tables.

Key words: Scientific calculators, mathematical tables, Students' attitude development

INTRODUCTION

Mathematics is a core subject in the Kenyan school curriculum for its utilitarian, personal, economic and cultural importance. It is therefore imperative that all students do well in mathematics in order to have a better career in future (Republic of Kenya; 1999). Indeed, the focus on mathematics in schools has been the development of procedural skills with algebraic expressions, often in complicated situations. Many students have required a great deal of time to develop such skills resulting in a majority abandoning the hope of doing so relatively early in their school encounter with mathematics.

The need to excel in mathematics gave rise to the creation of various devices aimed at helping learners to practice and solve problems accurately. First at elementary schools, counting sticks were used to quickly perform arithmetic. The counting rods could be transported easily and made calculations manageable to many people. Even today learners in primary school are using counting sticks and bottle tops as counting devices (Ellington, 2003).

The abacus is another device that has been used over the years for the same purpose. It provides students with many advantages including an understanding of the base-10 number system. It also helps to develop mental structures where many students using the Abacus can figure out problems with great speed and accuracy. The greatest drawback of Abacus in manipulations is that it can only be used for addition, subtraction, multiplication and division (Fennema and Sherman, 1976).

The slide rule on the other hand can be used to add and subtract logarithmic distances. It can be used to calculate artillery fire ranges and in complicated numerical computations. Complex operations of multiplication, division, square roots and trigonometry are all possible with the slide rule but it cannot be used to compute simple addition and subtraction (Rodgers, 1996).

Later, Mathematical tables were developed to extract information concerning squares, square roots, cubes, cube roots, trigonometric ratios, logarithms and antilogarithms. Although all these information can be extracted, Mathematical tables have their own disadvantages. First, each information has its own table where students have to pick the correct answer. A student can

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easily confuse and read the answers from different tables from what is expected, thus making wrong entries which may affect their overall performance. Secondly, because of many tables, students are prone to making errors because of unsuccessful scrutiny. Lastly, students take a lot of time to read the answer because of the procedures to be followed (Lim, 1992).

The formidable problem currently facing mathematics instruction process in Kenya is the need to improve students' understanding and performance in Mathematics. Almost all of Mathematics syllabi clearly state that, a mathematics course is designed to enable the learner to acquire attitudes, skills and knowledge that will be relevant to his or her life after school (Kenya Institute of Education [KIE], 2002). It also aims at fostering a positive attitude towards appreciating the usefulness and relevance of Mathematics to a modern society.

Despite the aforementioned utility of mathematics, many students continue to perform poorly in Mathematics and consequently a persistent outcry from all stake-holders. Several factors have been fronted to explain the state of performance and these include the mismatch of the syllabus whereby a topic or a concept in mathematics may be taught in another subject before it has been systematically developed in mathematics (Bitter and Hartifield, 1993). Such topics are taught in a different way from the way it should be taught in mathematics. This may account for the difficulty in mastering that mathematical concept and may contribute to poor performance. In addition, the anti – mathematics attitude from teachers of other subjects who may give impression to students that they should not bother so much to comprehend mathematics is another factor. This goes a long way to impart a negative attitude in the pupils that affects performance (Hembree and Dessart, 1992).

However, there are inherent difficulties in the subject that contribute to poor performance. These include the abstract nature of mathematics, mostly unusual notations and difficulty of learning algorithms. These factors taken cumulatively constitute formidable hurdles to the learning of mathematics to secondary school students. There are also difficulties that arise from the classroom teaching methodology and the curriculum (Mulei, 2011; Wasike, 2013). These include lack of proper planning of lessons by teachers, poor classroom methodology, poor pace of work coverage at the expense of students' understanding, use of unsuitable learning resources, poor topic sequencing causing low mastery of pre – requisite skills for new topics and use of language that is not adapted to students' abilities and levels of understanding (Campbell and Stewart, 1993).

One way to overcome these difficulties is by introducing manipulative equipment in mathematics which allows and encourages active involvements of students in the learning process (Odhiambo, 2013; Wasike 2013). Manipulative equipments are useful tools for instruction especially in learning new mathematical concepts. Indeed, Williams (1988) asserts that there is need for transforming mathematics lessons into students focused environment with meaningful activities that promote efficient learning of mathematics in the classrooms. The teaching of mathematics in Kenya secondary schools could therefore greatly benefit from the use of a particular manipulative called the scientific calculator.

The calculator has great potential in assisting the teacher to teach mathematical concepts which are difficult to teach using conventional methods. Moreover, scientific calculators are perceived to provide students with needed opportunity to participate actively in the classroom (Dunham & Dick, 1984). They provide access to mathematics tables and some statistical computation. They handle larger and smaller numbers. Recently in Kenya, the Ministry of Education, (MOE) directed the use of scientific calculators both for Mathematics instruction and examination of candidates at secondary school level (KIE, 2002). They were introduced to aid in algorithmic instruction, facilitate concept development, enlarge the scope of problem solving, provide motivation and encourage discovery, exploration and creativity.

The central concern of this study was to investigate the effect of the incorporation of scientific calculators into secondary school mathematics teaching and learning. It would also assess any effect of calculators on motivation, attitude and performance of students in mathematics. It is hoped that this study would contribute to knowledge in the field of Education especially in teaching and learning of mathematics.

Statement of the Problem

Some of the primary reasons for teaching mathematics include training and disciplining the mind and promoting the development of logical and rational thinking skills. A historical analysis of the pattern and the trends of performance in mathematics conducted by the Kenya National Examination Council [KNEC] (2004) reveal that mathematics is the most poorly performed subject both in primary and secondary schools. The report shows that most students are unable to complete the number of questions expected of them in an examination. Some students start off but they are unable to go through the algorithm to arrive at an answer. It is not known whether students lack an understanding of the concepts or they do not understand how to use conventional methods in performing arithmetic. It is not also known whether or not they run short of time due to rigorous repetitive manipulation.

The introduction of electronic calculator appears to have support from individual and special interest groups who have voiced strong opinion, regarding their use in the classroom. However, the central question seems to be how to wisely use calculators as a tool to enable many

Table 1. Comparison of mean scores, standard deviation and mean gain obtained by students on SAQ.

SCALE	Pre-test		Post-test		Mean gain
	Mean	SD	Mean	SD	
Overall	42.50	9.95	74.70	11.71	32.2
Group E	43.50	8.40	85.20	10.73	41.70
Group C	41.50	11.50	44.20	12.69	2.70

Table 2. An independent samples t-test results of the post-test scores acquired on the SAQ.

SCALE	GROUP E		GROUP C		T-VALUE	C-VALUE
SAQ	MEAN	MS	MEAN	MS		
	85.20	115.20	44.20	161.00	25.20	1.658

students perform mathematical operations successfully. This study was therefore was designed to investigate if the integration of scientific calculators in the instruction and assessment of mathematics could improve students' performance in mathematics.

METHODOLOGY

The study adopted the pre- test post- test only equivalent groups design. There were a total of 1628 form three students in 39 public secondary schools in Mumias Sub County. From the sampled schools, simple random sampling was used to draw 208 form three students who took part in the research. In each selected school, simple random sampling was again used to assign each student to either control or experimental group. The two groups were given a pre-test attitude questionnaire to get their views about the learning of mathematics. Later on, the experimental group used the calculator in learning mathematics while the control group continued using mathematical tables. Both groups were then given a posttest attitude questionnaire after the instruction.

RESULTS AND DISCUSSION

In order to evaluate the effectiveness of Scientific Calculators on Students' Attitude towards the Mathematics Course, a Students' Attitude Questionnaire (SAQ) with 15 items was administered. The ranks (Likert type scores) were converted into ratio type scores basing on the fact that higher scores on the Likert scale means a positive attitude. Arithmetic mean of pre-test and post test scores on SAQ for Experimental and Control groups were summarized as in Table 1.

An inspection of Table 2 shows that the pre-test results seem similar. However, there was need to establish if these means are different. As such an independent samples t-test of the pre-test results on SAQ was calculated at 0.05 level of significance. The calculated t-value (t=1.429) was less than the critical value (1.658). This indicates non-existence of significant difference between the scores of the groups. It was therefore concluded that there is no significant difference in the attitude of the two groups in the pre-test.

Further, the post-test mean scores on SAQ suggests that the Experimental group acquired higher mean score (85.20) than the Control groups (44.20) and the overall mean score of the whole group. This seems to indicate that the students who used the scientific calculators had a better attitude than those ones who did not use. An independent samples t-test of the post-test results on SAQ was calculated at 0.05 level of significance to ascertain if indeed the mean scores were statistically different.

The calculated t-value (t=25.20) was greater than the critical value (1.658). This indicates existence of significant difference between the scores of the groups. The evidence at hand therefore suggests that the students who were taught mathematics concepts using scientific calculators showed a more positive attitude towards the mathematics course than those taught using mathematical tables. This implies that scientific calculators boosted the students' attitude towards the learning of mathematics.

This study investigated the effect of Scientific Calculators on Secondary school students' Attitude towards mathematics. Results got indicated that subjects taught using Scientific Calculators had higher mean (85.20) score compared to those taught with conventional method (mathematical tables) (44.20). The aforementioned result is an indication that use of scientific calculators is more effective than use of mathematical tables. The result shows that instructional method employed in the mathematics classroom play a central role in developing students' positive attitude towards mathematics learning. The result gives an unequivocal

support to Balogun and Olarewaju (1992), Akinsola (1994), Akale (1997), Olowojaiye (1999), (2000).

By utilizing scientific calculators, on students learning outcome, the teacher has established a structural framework which helps students to organize their learning in a systematic way for more efficient study thus, reducing the time spent on irrelevances. In this way, students were not bored with the lesson; there was that eagerness to study more. No wonder, the improvement in attitude. The use of scientific calculators may have helped the students to perceive learning as relevant and meaningful thus, fostering a positive attitude in them towards mathematics.

Since attitudes refers to those actions that results from and are influenced by emotion, consequently, the affective domain relates to emotion, attitudes, appreciations, and values. In the mathematics classroom the affective domain is thus concerned with students' perceptions of mathematics, their feelings towards solving problems, and their attitudes about school and education in general. Pleasant experience through innovative and clearly understood instructional methods employed by the teacher like use of scientific calculators will surely facilitate positive attitude toward mathematics.

Attitude cannot be easily separated from learning because they are acquired through the process of learning. Learning is a process of acquiring and retaining attitudes, knowledge, understanding, skills and capabilities (Farrant, 1994). Since learners are not born with attitudes but instead they acquire them when they got in contact with the new world thus attitude can be learned and teachers should strive hard to develop the right attitudes in their students through various means especially instruction method like use of scientific calculators.

Conclusions

The need to know the usefulness and efficiency of scientific calculators vis-à-vis mathematical tables in the teaching and learning of mathematics largely prompted the need for this study. The central objective of the study was to investigate the effectiveness of the scientific calculators on the students' attitudes in the teaching of mathematics at secondary school level. The two tools (scientific calculators and mathematical tables) were employed on the undertaking of the same tasks. The data derived from the two were compared to determine which tool was more effective in the amount of students' attitudes towards the mathematics course.

The working theory for this study was based on the fact that for good or bad, effective change can be promoted rather easily in a social system through a domino effect. The researcher therefore presumed that the scientific calculator has the prerequisite logical series of steps that can lead the students gradually in learning mathematics.

The use of scientific calculators has demonstrated a great potential to promote cognitive, affective and psychomotor skills of Form Three secondary school students in the mathematics topic of trigonometry. Apparently, two major advantages stand out from this concept of trigonometry being a difficult topic to teach by conventional methods, may be resolved by the use of scientific calculators that emphasizes collaborative learning, creativity, self-paced and individual learning.

The second is that the declining performance and students' interest in mathematics (stated as the formidable problem currently facing mathematics education at the secondary school level in Kenya) may be arrested by the use of scientific calculators.

As to whether the conventional methods of instruction can really help students achieve, the findings of this study indicate that mathematical tables are inferior when compared to use of scientific calculators in the learning achieved and on students' attitudes towards mathematics course.

The findings of this study suggest that the teaching of the mathematics course require use of scientific calculators envisaged as not only capable of illustrating the points of interest but also proficient in arousing motivation and raising questions. Instructional media is also credited with the power to direct learners' attention to the subject content as advanced by Gagne (1975) to enter into an experience that is memorable, to help learners to understand and remember what they read as postulated by Romiszouski (1988) and Farrant (1992). It is probable that the idea of using scientific calculators may have given learners the impression of learning by doing.

On the basis of these findings, the researcher advocates that since students like all other human beings have a limit to which they can grasp, perceive, conceptualize and apply what is orally or visually presented to them, then it is imperative that the learning of mathematical concepts be presented in such a way that scientific calculators can be used.

The implication from the above interpretation suggests that the level of attitude in learning of mathematical concepts of trigonometry is marked higher when the students are taught using the scientific calculators than when the mathematical tables are used. Further, it can be concluded from these findings that the addition of media such as scientific calculators to lecture, discussions and demonstrations in the teaching and learning of trigonometry in mathematics is likely to enhance students' attitude in mathematics.

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