IMPACT OF USING SCIENTIFIC CALCULATORS IN MATHEMATICS INSTRUCTION ON STUDENTS ACHIEVEMENT IN SECONDARY SCHOOLS IN EMBU COUNTY, KENYA

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ABSTRACT
Mathematics surrounds everyone and as such it is universal part of human culture. Mathematics is used throughout the world as an essential tool in many fields such as commerce, engineering and other sciences. Due to its importance and use in the learning of other subjects and its application in industry and real life situations, mathematics is compulsory for all students in Kenya and as such performance in mathematics is of concern to everybody. Use of scientific calculators was introduced in secondary schools in the year 2005 and the calculators were to be used from form three level. However, its influence on students' achievement in mathematics has not been established. The purpose of the study was to investigate the impact of using scientific calculators in teaching and learning mathematics on students' achievement in mathematics in secondary schools in Embu County. The study sought to determine whether there was a difference in achievement in mathematics when students used calculators in assessment. The study employed the descriptive survey research design. The research was carried out in nine secondary schools in Embu County. The subjects were form three students and stratified random sampling technique was used to draw the participating schools. The sample size was 370 students. The research instrument used was the Mathematics Achievement Test. The raw data obtained were scored, coded and analysed using both descriptive and inferential statistics involving *t*-test. The hypothesis was tested at $\alpha = 0.05$ level of significance. From the study there was evidence that there was no significant difference in achievement in mathematics when calculators were used and when they were not used by students. The findings provide guidance in calculator use to instructors and policy makers who are undertaking the quest to improve students' achievement. The findings also may help the curriculum specialists who are responsible for selection of curriculum materials on how calculators affect the curriculum.
Keywords: Mathematics Achievement, Student Achievement, Scientific Calculator.

INTRODUCTION
Mathematics is key to economic prosperity and generally a mathematically well-educated population will contribute to the country's economic prosperity. To remain competitive in the world economy, mathematics is crucial for economic development and for technical progress (Advisory Committee on Mathematics Education [ACME], 2011). To meet the world competitive ambitions of a knowledge-based economy the quality and size of young people engaged in mainstream mathematics and science education is crucial (Royal Society, 2011). Despite the wide applicability and everyday utility of mathematics, many students still perform dismally in the subject.

Mathematics is a core skill for all adults in life and is generally agreed that in order for adults to function (reasonably well) in an increasingly complex world they require a basic level of numeracy (Burghes, 2012). Mathematics plays a vital role and provides a solid foundation to many aspects of daily life. Mathematics is also important as a school subject because not only is it needed for sciences but also provides access to other courses such as engineering, psychology, sciences and social sciences (Norris, 2012). Mathematical knowledge is seen as crucially important and increasingly necessary in a range of life-skills (Ofsted, 2012). There is little doubt that mathematical skills are increasingly needed by all. As such, students' performance in mathematics is of great concern to education stakeholders.

Despite the important role that mathematics plays in society there has always been poor performance in the subject in national examinations. The Kenya Certificate of Secondary Education (KCSE) mathematics paper has two papers marked out of 200 marks. Table 1 shows the national performance in mathematics in Kenya from 2003 to 2013. The overall mean and standard deviation in mathematics has been on decline from 2003 to 2005.

The overall mean improved from 31.91 in the year 2005 to 38.08 in the year 2006 when the calculators were for the first time used in national examinations. The mean has been increasing slightly each year since 2006. A decrease in mean is noted in the overall performance in 2013 and 2014. A decrease was observed from 57.31 in the year 2012 to 48.04 in the year 2014. In Kenya, calculators are required for mathematics classes and are generally permitted or required on many standardized tests covering mathematics and science subjects.

Table 1: The KCSE Mathematics overall performance in Mathematics from 2003 to 2013

Year	Mean Score	Standard Deviation
2003	37.20	36.17
2004	37.20	35.85
2005	31.91	31.00
2006	38.08	35.00
2007	39.46	39.83
2008	42.59	41.53
2009	42.26	37.65
2010	46.07	40.02
2011	49.57	44.30
2012	57.31	46.20
2013	55.15	46.71
2014	48.04	42.94

Source: KNEC, 2015

To enrich students learning of mathematics technology is being used widely. Electronic technology such as scientific calculators is essential in teaching and learning mathematics for it positively impact the mathematics that is taught and enhances student learning (National Council of Teachers of Mathematics [NCTM], 2000). Scientific calculators are designed to calculate problems and are essential tools for teaching, learning and doing mathematics thus students can learn more mathematics deeply. They are used widely in any situation where quick accesses to certain mathematical functions are needed such as trigonometric functions and in situations requiring very large numbers. Calculators allow solutions to problems that cannot be solved by paper and pen methods alone. Scientific calculators facilitate problem solving in that they provide faster ways to compute and manipulate symbols. They reduce the drudgery of applying arithmetic and algebraic procedures when they are not the focus of the instruction. They also remove the unnecessary tediousness of simplifying algebraic expressions and solving equations (Department of Education, 2004).
There is, therefore, need to emphasize that paper and pencil manipulative skills, mental basic arithmetic skills and algebraic skills are very important despite the fact that students have scientific calculators. This is because a calculator cannot understand a mathematics problem but can help significantly in the solution of the mathematics problems. Calculator may be useful in developing and consolidating a concept but may not always be essential in assessing that concept (Department of Education, 2004). Calculators should be used to develop understanding, to extend learning and to assist in problem solving situations. Calculator is a tool for exploration and discovery in problem solving situations and when introducing new mathematical content.

Achievement in mathematics has been poor over the years. There has been a range of strategies and resources available to help students develop, consolidate and extend their mathematical understanding. New manipulative materials and devices of instruction such as electronic technologies and in particular scientific calculators have been introduced to secondary schools. However, the impact of using the scientific calculator in improving students' achievement in mathematics has not been investigated. Hence the study explored the effect of using scientific calculators in teaching and learning mathematics on students' achievement in mathematics in secondary schools in Embu County.

The objective of this study was to determine the effects of use of scientific calculators on achievement in mathematics by form three students in Kenya secondary schools. The hypothesis was that was no significant difference in achievement in mathematics when scientific calculators are used and when they are not used by students.

METHODOLOGY

The study adopted a descriptive survey design as it is concerned with the conditions or relationships that exist. In this study, subjects who have been exposed to a stimulus (use of calculator) were studied and the stimulus might have started much earlier on some groups. The independent variable (use of calculator) in the study had already occurred and the researcher started with the observations of dependent variable (achievement in mathematics) to see their relationships. The target population was form-three students in Embu County. There were 3028 form three students in Embu County. Stratified random sampling technique was used to draw the participating schools for it ensures inclusion in the sample of subgroups which otherwise would be omitted entirely by other small numbers in population. The criterion used for stratification was gender in that there were three categories namely boys', girls' and mixed secondary schools. For each category simple random sampling was done to select schools that were used for the study. The actual sample size used in the study was 370 students from the nine schools that were randomly selected. The subjects were used in their intact classes.

The instrument used was Mathematics Achievement Test (MAT) for students, which was administered to the students twice. The students did the MAT first without the calculator and after two weeks they did

the same MAT with the calculators. The MAT was administered to the students by their teachers while the researcher marked and scored the test. Data analysis was done quantitatively. The results were tabulated and summarized in tables.

RESULTS AND DISCUSSION

A total of 370 form-three students from nine secondary schools responded to the Mathematics Achievement Test. Out of these 41% were girls while 59% were boys. The means for the MAT were calculated and are given in Table 2. When the students used the calculator, the mean was 43.06215 and when they did not use the mean was 43.20810. According to the grading system, 40 to 44 score is a D+ so the mean score obtained of 43.06215 and 43.2081 is a grade of D+. The grade obtained is therefore the same. This implies that there is no major difference in the means when the students use the calculator and when they do not use.

Table 2: Average of Mathematics achievement test

	Mean
With calculator	43.06215
Without the calculator	43.20810

Item Susceptibility

The Head of Department in secondary school determined in advance of the data collection those MAT Items susceptible to being influenced by use of calculators. The means of the selected items were calculated and the results given in Table 3.

Table 3: Means of the selected items of Mathematics achievement test

Items	Mean with calculator	Mean without the calculator
Item 2	2.7	2.0
Item 6	1.6	1.8
Item 10	2.5	2.8
Item 11	1.2	1.0
Item 12	2.3	2.5

The results on Table 3 show no consistent pattern on the means in that the mean was higher sometimes when the students used calculator and other times when the calculator was not used. Thus investigation of item statistics revealed no discernible performance between when the students used calculator and when they did not. The results also show that the pattern appeared to be random with respect to when they scored better on the items. No great differences existed between when the students used calculators or not. This implies that students need to understand concepts in mathematics since calculators do not perform tasks but simplify the tasks. Mathematical tasks require thinking and understanding so students need to understand the mathematics of the problem they are going to solve. There was no difference in basic skills and problem solving skills when the students use calculators or not. This random pattern was consistent with the conclusion of the findings of Hembree and Dessart (1986) that calculator use had no effect on students' performance and also when students used calculators in concert with traditional instructions they maintained their paper and pencil skills without apparent harm.

Students' Achievement in Mathematics

H_O1 stated that there was no significant difference in achievement in mathematics when calculators were used and when they were not used by students. The independent variable was use of calculator and the dependent variable was achievement in mathematics. The aim of testing was to ascertain whether the use of calculator in mathematics teaching and learning had influence on students' achievement. To achieve this aim the test was administered to students with and without calculators. The results obtained enabled the researcher to describe the hypothesis that there is no significant difference in achievement in mathematics when calculators are used and when they are not used by students. The mean, standard deviation and t-test of the scores of Mathematics Achievement Test were calculated. The results are given in Table 4.

Table 4: The mean, standard deviation and t-test of the scores of Mathematics achievement test

	Without calculator	With the calculator
Mean	43.20810	43.06215
Standard deviation	10.12314	10.19931
Sample size	370	370
t-computed	0.62275	
t-critical	1.96	

The t- computed was less than t-critical and so the difference between the two results was not significant at the 5% level and the null hypothesis was retained (Table 4). The t-test results analysis revealed that the measures were not statistically different at 0.05 α-level and so there was no significant impact on the use of calculators and achievement in mathematics. This implies that in teaching and learning of mathematics, calculators are used to serve many of the same purposes as other concrete materials. These

results are not consistent with research findings of Suydam (1985) who showed that achievement in problem solving increases when the students use calculators and that one carried out by Grouws and Cebulla (2003) who found out that use of calculators increase achievement. Also Smith (1996) found out significantly higher achievement for students who used calculators for problem solving, computation and conceptual understanding compared to students who did not use calculators. The results concur with Ballheim (1999) who found out those students who used calculators during instruction did not perform significantly higher on tests of mathematical achievement without calculators than their non-calculator counterparts.

CONCLUSION

The results from the study show that there was no major difference in means when the students used the calculators and when they did not use in MAT. The students need to be able to decide what information to enter and what operations to use on the calculator. Calculators should be used only after the students have mastered the basic computational skills and also have acquired conceptual and procedural knowledge. Calculators should be used to check computation and facilitate problem solving for it does not understand the mathematical tasks on its own. In addition, students require mathematical skills and their abilities whether they have calculator or not to solve mathematical problems.

A calculator is one of several tools for learning and teaching mathematics hence learners need to be guided on how best they can use calculators to ease the mathematical tasks. The students need to understand how calculators work to use them appropriately to improve the achievement. They should also be provided with instructions for the appropriate and effective use of calculators.

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