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Research Paper

Effectiveness of Cooperative Learning Strategy on Students' Achievement in Mathematics in Secondary Schools in Meru South Sub-County, Kenya

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ABSTRACT

Achievement in Mathematics at Kenya Certificate of Secondary Education (KCSE) examinations has been poor over the years. The low achievement has partly been blamed on teaching methods which do not actively involve learners in the learning process depriving them of taking charge of their learning. Cooperative Learning (CL) is one of the innovative ways through which learners can be involved in the learning process. The aim of this study was to investigate the effectiveness of cooperative learning strategy in enhancing students' achievement in Mathematics in secondary schools in Meru South Sub- County. The study employed the Solomon Four-Group, Non-equivalent Control Group Design. The target population for the study was 2430 form three students in 44 co-educational secondary schools in Meru South Sub-County. The sample comprised of 164 form three students from four co-educational schools within the Sub-County. Random sampling was used to select the four schools from a list of prequalified schools. Prequalification was done based on number of students, students' entry behaviour, availability of teaching/learning resources and teachers' qualification. Simple random sampling technique was used to assign participating schools to experimental and control groups. A Mathematics Achievement Test (MAT) and Students' Attitude Questionnaire (SAQ) was administered to assess the students' achievement and attitude towards Mathematics. The reliability of the research instruments was estimated using Cronbach's Alpha. A reliability coefficient of 0.82 for SAQ and 0.79 for MAT was obtained. Validity of the instruments was ensured through expert judgment. The instruments were administered with the assistance of Mathematics teachers in the respective schools. Data was analyzed using both descriptive and inferential statistics. The difference between group means was checked for statistical significance using t-test, ANOVA and ANCOVA. The hypotheses were tested at $\alpha=0.05$ significance level. Means were separated using Least Significant Difference (LSD) pair wise post-hoc comparisons. The study established that students who were taught through cooperative learning (CL) achieved relatively higher scores in MAT and SAQ than those exposed to conventional teaching methods (CTM). Based on the findings of this study, education authorities should encourage Mathematics teachers, curriculum developers and teacher training institutions to use CL in teaching and learning of Mathematics in secondary schools.

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Mathematics is for life and is done in one way or the other in daily activities in society (Jebson, 2012). According to Azuka (2000), Mathematics skills are used in every day decision making by people in society. Mathematics also allows for advancement in technology. Things ranging from the hydrogen bomb to compact discs would not have been possible to build without knowledge of Mathematics (Smit, 2010). Mathematics is a fundamental part of human thought and logic, and integral to attempts at understanding the world and ourselves (Lynn & Brocado, 2009). Mathematics provides an effective way of building mental discipline and encourages logical reasoning and mental rigour (Skemp, 2008). Umameh (2011) holds that Mathematics teaches children important problem-solving skills that they can apply to other aspects of their lives and helps them to think in a logical manner, and also view and analyze things in a more sophisticated way. Schoenfield (2012) observes that Mathematical knowledge plays a crucial role in understanding the contents of other school subjects such as science, social studies and even music and art. Broadly, it forms the basis of many of the sciences, such as physics and astronomy (Lyons, 2008). Mathematics is an important subject not only from the point of view of getting an academic qualification at school or college, but also is a subject that prepares the students for the future as well, irrespective of which walk of life they choose to be a part of (Davis & Hersh, 2012).

According to Eshiwani (1993), the major aim of Mathematics education in Kenya is the development of thinking abilities and logical thought. Eshiwani (1993) further notes that due to its importance and use in the learning of other subjects, its core consideration in career choices such as medicine, engineering and education among others and its application in industry and real-life situations, Mathematics is compulsory for all secondary students in Kenya. This calls for expertise in Mathematics learning and use of appropriate methodologies. According to Obodo (2012), Students are unlikely to learn unless they are involved in the process of learning; they rarely learn much when they are treated as simply as passive receptors. This therefore implies the need to review the methods being employed in the teaching of Mathematics if the objectives of Mathematics education are to be achieved.

Tsuma (1998) holds that the most serious problem in Africa today is the quality of education in Mathematics and Science that has continued to get worse. According to Ogunniyi (1996), a steady decline in academic scores of high school students in Mathematics and Science has caused a deep concern in many African countries. Several reasons have been established for these high failure rates in Mathematics. Skemp (2008) reveals that the failure rate in Mathematics in Zimbabwe schools is unacceptably high. Nyaumwe (2004) established that some of the methods teachers used to teach Mathematics in Zimbabwe did not help students develop conceptual understanding of Mathematics, hence the high failure rate in the subject in Zimbabwe. In South Africa, a study by Samuelson (2011) on students' perceptions of Mathematics in secondary schools revealed that students thought that teachers who did not have competence in teaching Mathematics and those who did not understand all the chapters in Mathematics textbooks were unlikely to assist students in solving problems in Mathematics especially in the topics they did not understand. Students also cited that teacher absenteeism resulted to inadequate coverage of the syllabus, thereby contributing to the high failure rate.

According to Vundla (2012), shortage of well-trained teachers, inadequacy of teaching facilities, lack of funds to purchase necessary equipment, poor quality textbooks, large classes, poorly motivated teachers, lack of libraries, constant transfers of teachers, automatic promotion of learners and inequality in education opportunities all hinder the smooth acquisition of Mathematics knowledge. Johnson and Johnson (1991) attributes some of the causes of poor performance to the poor instructional approaches used by teachers in which over 85% of the instruction consists of conventional techniques thereby giving students little opportunity to interact. According to Tsuma (1998), conventional teaching methods make learners to be passive recipients rather than active participants in the construction of knowledge.

In Kenya, students' achievement in Mathematics at KCSE level has been poor (KNEC, 2013, 2014 & 2016). Mathematics mean scores have remained below 30% from the years 2008 to 2015 at KCSE, with the highest mean score attained over the period being 28.66% in 2012 and the lowest being 21.13% in 2009. This is so despite the various interventions made to improve performance. A study by Mbugua, Kibet, Muthaa and Nkonke (2012) in Kenya revealed that under staffing, inadequate teaching/ learning materials, lack of motivation, poor attitudes by both teachers and students and retrogressive practices were factors contributing to students' poor performance in Mathematics at KCSE. According to Polya (2011), one of the most important factors for improving performance is students' involvement. The aim of this study therefore was to investigate whether students' involvement in learning through cooperative learning teaching strategy enhances their achievement in Mathematics.

METHODOLOGY

The study employed Solomon Four-Group, Non-equivalent Control Group Design. Borg and Gall (1989) hold that this design is rigorous enough for experimental and quasi-experimental studies. It combats many internal validity issues that can affect research so that the observed effect on the dependent variable can be attributed solely to the treatment and allows the researcher to exert complete control over the variables and to check that the pretest does not influence the results (Shuttleworth, 2009). Through this design, intact classes were randomly assigned to four groups. Intact classes were used because school authorities do not allow classes to be reconstituted for research purposes. The design is illustrated below.

Group 1	O1	X	O2
Group 2	O3	–	O4
Group 3	–	X	O5
Group 4	–	–	O6

In this design, group 1 was the experimental group that received the pre-test (O1), the treatment (X), and the post-test (O2). Group 2 was the control group that received the pre-test (O3), post-test (O4), but no treatment. Group 3 on the other hand was the experimental group that received the treatment (X), post-test (O5), but no pre-test. Group four was the control group that received the post-test (O6) only. The post-test O5 and O6 are meant to rule out any interaction between testing and treatment. The groups' equivalence were assessed before the start of the experiment through the use of pre-test. The experimental and control groups were from different schools to avoid experimental contamination as a result of interaction by respondents.

The design may however not control for those threats associated with interaction of selection and history, selection and maturation, as well as selection and instrumentation (Cook & Campbell 1979). According to Barchok (2011), the researcher can endeavor to control these threats by randomly assigning participating schools to the control and treatment groups and keeping as similar as much as possible across the schools, the conditions under which the instruments will be administered. A common manual on cooperative learning was used to train teachers in experimental groups on the use of cooperative learning strategy to ensure uniformity in exposure of students to the strategy. Teachers involved in the study also adopted a common scheme of work for the topic of Trigonometry (2) to ensure the content is uniformly covered for all the groups in the study. To control maturation as a threat to internal validity, students in form three, assumed to be of approximately of the same age were used in this study.

The study was conducted in Meru South Sub-County, Tharaka Nithi County, Kenya. Singleton (1993) notes that an ideal reason for the setting for any study should be the existence of a problem that the study hopes to generate solutions for. The study location was chosen because it had been established that students' achievement in Mathematics in national examinations in the Sub-County had been poor.

The target population for the study was 2430 form three students in 44 co-educational secondary schools in Meru South Sub-County (Meru South Sub-County Education Office, 2015). Since the study considered the aspect of gender in performance, co-educational schools were the most suitable for the study. Co-educational schools accounted for 83% of all the secondary schools in the Sub-County enrolling majority of the students in the Sub-County.

Co-educational secondary schools formed the sampling frame for this study. The researcher first prequalified the schools to ensure similarity in their characteristics. Prequalification was done based on number of students, students' entry behaviour, availability of teaching/learning resources and teachers' qualification. Four co-educational schools were then selected randomly from the list of prequalified schools. The assignment of selected schools to either experimental or control group was done by simple random sampling. In cases where the selected school had more than one stream, all the streams were involved in the study, but random sampling was used to select one stream for analysis. Mugenda and Mugenda (2003) hold that for experimental studies, at least 30 cases are required per group. The sample size for this study was 164 students as shown in Table 1.

Table 1 Number of Students per Group in the Study Sample

Groups	Number of Students
Experimental (1)	39
Control (2)	49
Experimental (3)	32
Control (4)	44
Total	164

Instruments

The study used Mathematics Achievement Test (MAT) for data collection. The researcher developed the MAT comprising of 6 questions on the topic of Trigonometry (2). MAT was used as a pre-test to measure students' achievement in Mathematics. It was then adjusted for use as a post-test. Students Attitude Questionnaire (SAQ) was adopted from Tapia and Marsh (2004) and modified to suit the study. It contained forty items of five point-likert scale designed to measure the level of attitude and interest towards learning of Mathematics.

RESULTS

The study sought to determine whether there was any statistically significant difference in Mathematics achievement between students exposed to cooperative learning (CL) and those exposed to conventional teaching methods (CTM) in secondary schools in Meru South Sub-County. The post-test means scores of the four groups involved in the study are presented in Table 2.

Table 2 Post-test Mean Scores Obtained by the Four Groups

Group	N	Mean	Maximum Score	Std. dev
Experimental 1	39	18.8	40	3.32
Control 2	49	13.04	40	4.21
Experimental 3	32	19.9	40	3.3
Control 4	44	12.21	40	7.6

The results in Table 2 show that group 3 had the highest mean (19.9) followed by group 1 with a mean score of 18.8. Group 2 and 4 had relatively lower mean scores of 13.04 and 12.21, respectively. This is an indication that the experimental groups achieved relatively higher than the control groups in the MAT post-test. To determine whether the difference in the mean achievement of the four groups was statistically significant, ANCOVA was run. The results are presented in Table 3.

Table 3 ANCOVA of Post-test Scores on MAT with KCPE Mark as a Covariate

Source Variation	Type III Sum of Squares	Df	Mean Square	F	P-value
KCPE	116.451[a]	3	6.317	45.409	.000
Groups	122.000	161	3.231	47.331	.000
Error	2.028	164	1.114		

a. R Squared = .775 (Adjusted R Squared = .694)

Using students' KCPE examination scores as covariates, the results revealed that the differences in the mean scores of the four groups were statistically significant at $\alpha=0.05$ significance level ($F(3,161) = 45.409$, $p<0.05$). To determine where the groups differed after mean adjustment, a least significant difference (LSD) post hoc comparison was done, based on ANCOVA. The results are presented in Table 4.

Table 4_LSD Post Hoc Comparisons of Post-test on MAT Group Means based on ANCOVA

(I) Group	(J) Group	Mean Difference (I-J)	P-Value
1	2	-2.80272*	.000
	3	-5.23429	.061
	4	-10.11529*	.000
2	1	2.80272*	.000
	3	-1.42857*	.010
	4	-5.22857	.056
3	1	5.23429	.061
	2	1.42857*	.010
	4	-2.80000*	.000
4	1	10.11529*	.000
	2	5.22857	.056
	3	2.80000*	.000

** The mean difference is significant at α=0.05 significance level.*

From Table 4, it can be observed that the post hoc pair wise comparison based on ANCOVA revealed that there was significant difference between groups 1 and 2, 1 and 4, 2 and 3, and 3 and 4. It was also established that the differences between groups 1 and 3, 2 and 4 were not statistically significant at α=0.05 significance level. It is also evident from Table 11 that the MAT post-test mean scores of control groups 2 and 4 were significantly lower than those of experimental groups 1 and 3.$H_0$1 was therefore rejected

DISCUSSION

This study established that the achievement of students taught through cooperative learning strategy (group 1 and 3) was higher than that of those taught through the conventional teaching methods (group 2 and 4). This was evident by the significantly higher mean scores obtained in MAT by Experimental group 1 and 3 as compared to Control group 2 and 4.

Cooperative learning usually supplements the teacher's instruction by giving students opportunities to use mathematical language to discuss concepts or practice skills originally presented by the teacher, apply Mathematics skills and concepts, reason and problem solve with peers and make connections to other skills and disciplines, with the teacher's role changing from giving information to facilitating students' learning (Slavin, 1995). These results agree with Abrami, Poulsen and Chambers (2004) description of cooperative learning as an instructional strategy in which students work actively and purposefully together in small groups to enhance both their own and their teammates learning. The findings are also in agreement with McKeachie (2002) who asserted that students learn more by doing something active than by simply watching and listening, and that cooperative learning is by its nature an active method.

A study by Elvis (2013) on teaching methods and students' academic performance revealed that conventional teaching methods were the least effective teaching methods in enhancing students' academic performance with comparison to teacher-student interactive methods and students-centered methods. The findings of a study by Abdullah (2010) that investigated the effects of using cooperative learning on the academic achievement of students in Mathematics showed that education through cooperative learning was better than the traditional way of teaching, in improving the academic achievement of students in Mathematics. Another study by Effandi, Titi, Yusoff and Zulkarnain (2013) established that Mathematics mean scores of secondary school students in the cooperative group was higher than that of the traditional group. Moreover, the results of this study agree with Isik and Tarim (2009) study that found increase in students' Mathematics achievement when cooperative learning is used.

From the foregoing, it can be concluded that cooperative learning strategy proved more effective than the conventional teaching method in enhancing students' achievement in Mathematics in secondary schools.

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Conflict of Interest
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