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EFFECTS OF JIGSAW COOPERATIVE LEARNING STRATEGY ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOL MATHEMATICS IN LAIKIPIA EAST DISTRICT, KENYA

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ABSTRACT

Knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society. It equips students with unique and powerful set of tools to understand the world and become productive members of the society. Secondary school students in Kenya have continued to perform poorly in mathematics at the Kenya Certificate of Secondary Education (K.C.S.E) national examinations. This raises concern for all stakeholders in education due to the importance they attach to mathematics. Some of the factors that are attributed to the students' dismal performance in the subject include; inadequate facilities in the schools like the text books and qualified teachers, poor attitude towards the subject by the students and teachers, gender stereotypes, lack of role models for girls, and the ineffective instructional methods used by teachers. This study sought to find out if the use of Jigsaw Cooperative learning Strategy during instruction of Surds and Further logarithm in mathematics to form three 17 year old students had effects on their performance. Surds and Further logarithm are topics that are performed poorly at the KCSE. There is however inadequate documented information in research conducted in Kenya on effects of the use of Jigsaw Cooperative learning Strategy on students' achievement in mathematics. Solomon four non-equivalent control group research design was used in the study. The two experimental groups received the Jigsaw cooperative learning Strategy as treatment and two control groups were taught using the conventional learning/teaching methods. A simple random sample of four co-education district secondary schools was selected from Laikipia East District. The sample size was 160 students out of a population of about 20,000 students in the district. A mathematics achievement test (MAT) was used for data collection. The instrument was validated and had reliability coefficient of 0.87. Data was analyzed using t and ANOVA tests to test hypothesis at 0.05 significance level. Findings of this study show that learners taught using Jigsaw cooperative learning strategy performed better than those taught using Conventional learning methods. The results also show that there is no significant gender difference in achievement when learners are taught using Jigsaw cooperative learning strategy. Conclusions, implications and recommendations of the study are summarized.

Keywords: Jigsaw Cooperative learning Strategy, achievement in mathematics

INTRODUCTION

Despite the important role mathematics plays in society, there has been persistent poor performance in the subject globally. The United States of America (U.S.A) for example which is viewed as a global leader in many aspects, including finance, medical research, higher education, sports and scientific fields has lagged behind other countries of the world in learners` mathematics achievement as indicated by Trends in International Mathematics and

Science Study (TIMSS, 2007). In Africa poor performance is also registered in mathematics. South African learners who participated in the 1995 TIMMS for example, were ranked last with a mean score of 351 which was lower than the international benchmark of 513. In Kenya, the performance in mathematics has continued to be very poor at the Kenya Certificate of Secondary Education (K.C.S.E) national mathematics examinations (K.N.E.C, 2011). The students' low mean scores in mathematics at K.C.S.E national examinations by gender in the years 2009 and 2010 are shown in Table 1.

Table 1: Students' Percentage Mean Score in Mathematics at KCSE for the years 2009 and 2010

Year	*Male*	*Female*	*Grand mean*
2009	23.63	18.11	20.87
2010	25.75	19.71	22.73

Source: K.N.E.C, 2010

A report by the Kenya National Examinations Council indicated that national mathematics grand mean scores of 20.87% and 22.73% at KCSE during the years 2009 and 2010 respectively were below 25%. There has also been serious implications in that candidates lack admissions to careers in institution of higher learning for science related courses . Employers have also taken particular interests in this problem and criticized the school inability to teach mathematics effectively. For this reason parents have began to send students for private tuition in mathematics.

The persistent poor performance in mathematics is also registered in Laikipia East District of Kenya where the study was carried out. The students' performance indices in mathematics out of twelve points at K.C.S.E in the years 2006, 2007, 2008 in the District were 2.93, 2.61, and 3.13 respectively. The underachievement and gender differences in learners mathematics performance in Kenya is attributed to ineffective teaching methods employed in mathematics classrooms (O'Connor, 2000) among other factors.

In Africa the factors attributed to learners' poor performance in mathematics includes: inadequate teaching and learning resources; negative teacher/learner attitude towards the subject; and ineffective teaching methods (Miheso, 2012 ; Opolot-Okurot, 2005). Factors that contribute to poor performance in Africa in general and Kenya in particular are similar. There is therefore need for teaching strategies that arouse students' interest to learn mathematics and hence improve the quality of outcomes in mathematics classrooms.

This study therefore sought to find out the effects of the use of Jigsaw Cooperative Learning Strategy during instruction on learners' achievement in the topics Surds and Further logarithms that are taught to form three 17 year old students in Laikipia East District of Kenya. Cooperative learning is a teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of subject matter (David & Roger, 2001). Each member of a team is responsible not only for learning what is taught but also for helping teammates learn, thus creating an atmosphere of achievement. Students work through the assignment until all group members successfully understand and complete it.

Earlier studies have shown that learners who perform cooperative learning group tasks tend to have higher academic test scores, higher self esteem, greater numbers of positive social skills, and greater comprehension of the content and skills they are studying (Johnson, Johnson & Holubec, 1993; Slavin ,1991).In this learning arrangement students work in groups of 5 to 6 cooperatively to ensure their own learning and the learning of all others in

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their group (Johnson, Johnson & Holubec, 1993).This emphasis on academic learning success for each individual and all members of the group is one feature that separates cooperative learning groups from other group tasks (Slavin, 1991).

To be successful in setting up and having students complete group tasks within a cooperative learning framework, a number of essential elements or requirements must be met (Cohen,1992) which includes: a clear set of specific student learning objectives, clear and complete set of task-completion directions or instructions, heterogeneous groups, equal opportunity for success, positive interdependence, face-to-face interaction, positive social interaction behaviors and attitudes, access to must-learn information, opportunities to complete required information-processing tasks, sufficient time is spent learning, individual accountability, public recognition and rewards for group academic success, post-group reflection (or debriefing) on within-group behaviors .

According to Aronson (2000). Jigsaw is a cooperative learning strategy that enables each student assigned to a group or 'home' group to specialize in one aspect of a learning unit. Students meet with members from other groups who are assigned the same aspect of a topic and after mastering the material, return to the 'home ' group as experts and teach this material to the group members. Jigsaw can be used whenever material can be segmented into separate components. Each group member becomes an expert on a different concept or procedure and teaches it to the group (Panitz, 1996). Like a Jigsaw puzzle, each piece (student part) is essential for the completion and full understanding of the final product. Therefore, each student is essential for the understanding of the whole concept being taught. According to (Aronson, 2000) the advantage of Jigsaw learning strategy is that students perform the challenging and engaging tasks in their expert groups with enthusiasm since they know they are the only ones with that piece of information when they move to their respective groups. Students who tutor each other develop a clear idea of the concept they are presenting and orally communicate it to their partner (Neer, 1987).

The Jigsaw learning strategy can be used to learn most of the topics in Kenyas` secondary school mathematics syllabus. The effect of the strategy on learners` achievement in the mathematics topics Surds and Further logarithms was studied. These are major topics in the secondary school mathematics curriculum taught to form three 17 year old students (KIE, 2002). They have been among the difficult topics for students to learn in the secondary school mathematics syllabus in Kenya in which learners obtain low scores in national examinations (KNEC , 2010) and hence the need for the study.

PROBLEM OF THE STUDY

Despite the usefulness attached to mathematics for an individual and society, learners` achievement in the subject at the end of primary and secondary school national examinations has remained low worldwide. Among many factors contributing to learners` low achievement are the ineffective teaching methods used in mathematics classrooms. In an attempt to seek a teaching strategy to improve learners` mathematics achievement, this study investigated the effect of Jigsaw cooperative learning /teaching strategy on secondary school learners` mathematics achievement in selected topics in Laikipia East district of Kenya.

PURPOSE OF THE STUDY

The purpose of this study was to investigate the effects of Jigsaw cooperative learning strategy on students' achievement in secondary school mathematics.

HYPOTHESİS OF THE STUDY

The following Null hypothesis was tested at the 0.05 significance level.

Ho1; There is no statistically significant difference in students' mathematics achievement between students who are taught mathematics using Jigsaw Cooperative Learning Strategy

and those taught using Conventional Learning/Teaching Methods.

CONCEPTUAL FRAMEWORK

The conceptual framework of the study was based on the Ausubel's model of meaningful reception learning and systems theory developed by Ayot and Patel (1987). The framework shows Jigsaw teaching strategy as an intervention in the teaching and learning process of mathematics.

The representation of the relationship among variables within the conceptual framework is shown in Figure 1.

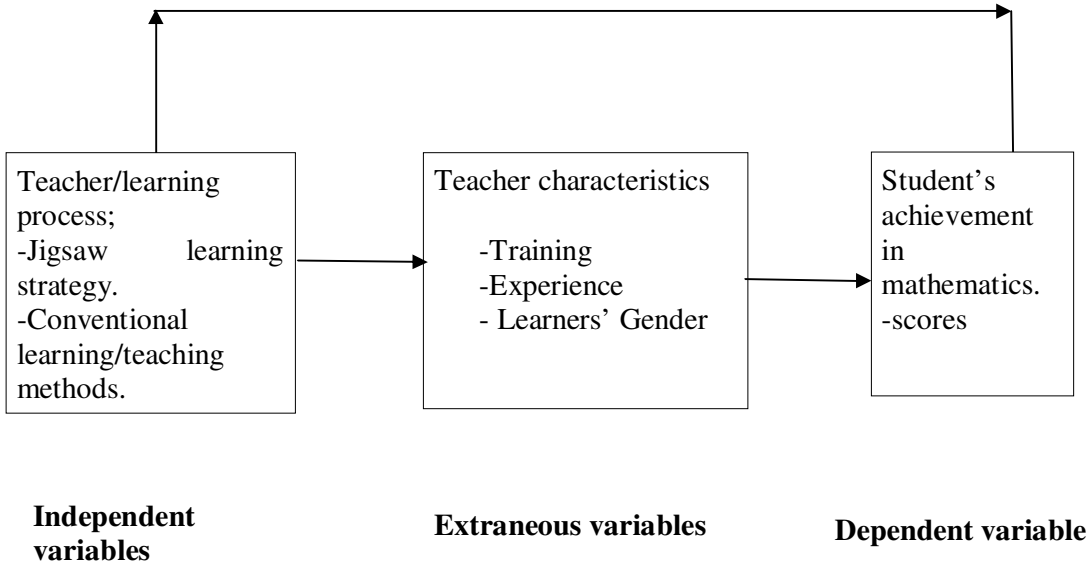

Figure 1: The Diagrammatic Representation of the Relationship Between the independent, extraneous and dependent variables of the Study.

The framework shows Jigsaw cooperative learning/teaching strategy as an independent variable of the study. The dependent variable was the students' achievement in Surds and Further Logarithms. The independent variables were the Jigsaw learning strategy presented to students and the 'conventional' or traditional learning/teaching methods. Jigsaw cooperative learning strategy was hypothesized to influence positively students' achievement in mathematics as compared to the use of 'conventional' or traditional teaching methods. The extraneous variables which could have influenced the outcome of the study were the teachers' and students' characteristics. The teachers' characteristics were controlled by using teachers who have a minimum qualification of a diploma in education and have taught form three class for at least 2 years. The learners' characteristic of gender was studied alongside the independent variables. This assisted in knowing whether gender as a variable had any effect on the dependent variable after using Jigsaw cooperative learning/teaching strategy.

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RESEARCH METHODOLOGY

The study used a quasi-experimental method to explore the relationship between variables, as the subjects are already constituted and school authorities don't allow reconstitution for research process (Borg & Gall, 1989). This study used the Solomon 4-group, non equivalent control group research design shown in Figure 2 which is appropriate for experimental and quasi-experimental studies (Ogunniyi, 1992). The design overcomes external validity weaknesses found in other designs and also provides more vigorous control by having two control groups as compared to other experimental designs. This design involves a random assignment of intact classes to four groups.

_ GROUP	NOTATION
E_1	0_1 X 0_2 (Experimental group)
C_1	0_3 - 0_4 (Control group)
E_2	- X 0_5 (Experimental group)
C_2	- - 0_6 (Control group)

Figure 2: The Solomon 4-group, non-equivalent control group design.

In Figure 2, the variables are defined such that: O_1 and O_3 are pretest; O_2, O_4, O_5, O_6 are post-test; and X is treatment. Group E_1 received pre-test, treatment and post test; Group C_1 received pre-test and post test without treatment; Group E_2 received the treatment and post-test; Group C_2 received post-test only. Two schools were experimental schools and in the experimental schools one received post test only while the other received post test and pre-test. The other two schools were control schools and in the control schools, one received post test only while the other school received post test and pre-test. The effects of maturation and history were controlled by having two groups taking pre- test and post tests. To avoid contamination, the treatment and control groups were from different schools. The regression effects were taken care of by two groups not taking pre-tests. The same teachers who had been teaching the students were used by the researcher teaching in the classroom. The treatment was administered to the whole form three classes to avoid Hawthorne effect.

The pre-test was treated as a normal classroom test that students regularly take in the course of instruction while the post test was taken as a normal test that is administered after a topic has been covered. The mathematics teachers in the two experimental schools were given a guide on how to teach the topic by the researchers when students were on recess. However, only the results from one stream in each school were used in the analysis of data and for the acceptance or rejection of the hypotheses of the study.

Population of the Study

The target population was 10,800 secondary school students in Laikipia East District. The accessible population was form three 17 year old mathematics secondary school students in the District mixed-sex schools in Laikipia East district because the topic surds and logarithms is taught at this level (KIE, 2000) which is not an examination class. There is 1 provincial

school and 32 district schools in Laikipia East District. Twenty-seven (27) of the 32 District schools were mixed-sex schools. The mixed-sex schools were used for this study because they are mostly disadvantaged compared to single- sex schools in terms of low achievement in mathematics. Laikipia East District was chosen for this study because of its dismal performance in mathematics compared with other Districts in Rift valley Province of Kenya.

Sampling Procedure and Sample Size

Simple random sampling was employed to select four schools out of the possible 27 mixed-sex District schools in the District. Four schools were chosen because the Solomon 4 group design requires four groups. Each school formed a group in the Solomon 4 group design so that interaction by the subjects was minimized during the exercise. The assignment of groups to either experimental or control groups was done by simple random sampling. The classes used for the exercise were composed of 40 students each. According to Mugenda and Mugenda (1999) the required size is at least 30 per group.

Instrumentation

The Mathematics Achievement Test (MAT) was used to collect the required data. It was a 36 item instrument that tested the student's knowledge, comprehension, application and mathematical skills on working out short answer questions that was set on all the subtopics of surds and further logarithms. The total score for the instrument were 80 marks. These scores were distributed to 36 items. The items were allocated between 1 to 3 marks each. It was validated and had a reliability coefficient alpha of 0.87. Two schools, one experimental and the other control received a pre-test to enable the researcher to have knowledge of the entry level of the students before the experiment began.

How Jigsaw Learning Strategy was used to Teach

The topics that were taught by use of Jigsaw cooperative learning strategy were Surds and Logarithms to form three 17 year old students in secondary schools .The subtopics of Surds were; rational and irrational numbers, operation on Surds, rationalizing the denominator and applications of Surds. The subtopics of Further Logarithms were logarithmic notations, laws of logarithms, logarithmic expressions and, logarithmic equations. Appropriate group work for each of the sub topics were constructed and used during instruction at the beginning of each mathematics lesson. For each of the subtopics to be taught the ten steps of creating and use of Jigsaw cooperative learning strategy was followed as recommended by Aronson (2000) . The group work was assigned to the groups and each student in the group assigned questions. The students with the same questions formed the expert group where they discussed their written answers to the questions The students then went back to their initial group to present their findings to the other members of the group. All this was done with close supervision of the teacher. The teachers then evaluated the learners by asking questions that demanded written answers and gave them feedback. Finally MAT post-test was administered

RESULTS

Pre- test analysis

Prior to treatment, data was collected from the subjects in experimental group (E1) and control group (C1) using MAT to make it possible for the researcher to assess the homogeneity of the groups before treatment application (Gall *et al*., 1996). Table 4 shows the t-test pretest results obtained from groups E1 and C1 on the MAT.

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Table 4. Pre-test mean scores on MAT and t-value results

Leaning Method	*N*	*Mean*	*SD*	*Df*	*T-value*	*p-value*
Experimental 1	38	16.47	11.72	74	0.879	0.382
Control 1	38	14.18	10.98			

* Statistically significant at 0.05

The results shown in Table 4 indicate that the differences between mean scores of groups E1 and C1 on the MAT was not statistically significant at the ά=0.05 significance level using the t-value. The P-value is greater than 0.05, an indication that the groups were homogeneous and thus suitable for the study.

Effects of the Jigsaw Learning Strategy on the Students' Achievement

The results presented in Table 5 show the students' MAT mean gain on E1 and C1 groups. Mean gain is the difference between the pretest and the post test score of the same group. The data indicated that the mean gain of the E1 group is 13.68 and the mean gain of C1 group is 0.76. Thus the mean gain of E1 group is higher than the mean gain of C1 group. Further statistical test using t-test at ά=0.05 significance level (Table 5) also show that there is significant difference between the mean scores of the E1 and C1 groups ($P < 0.05$). This difference can be attributed to the Jigsaw learning strategy influence on the students' achievement on the mathematics topics surds and further logarithms. Table 6 show post-test mean scores for the four groups and Table 7 show results of ANOVA test on post-test mean scores.

Table 5. Comparison of the Mean Score Gain Obtained in the MAT

Learning method	N	Post-test	Pr-test Mean	Mean gain Mean	`df	t-value	p-value
Experimental1	37	29.58	16.47	13.68	73	6.86	0.000*
Control 1	38	14.95	14.18	0.76			

*Statistically significant at 0.05.

Table 6. Students' post-test mean scores in the MAT Obtained by the Students in the Four Groups

Learning method	*N*	*Mean*	*SD*
Experimental 1	40	29.58	16.56
Experimental 2	42	33.79	13.58
Control 1	38	14.95	11.95
Control 2	40	16.96	9.91

Table 7. Comparison of Students' Post-Test MAT Scores using ANOVA

Source	*Sum of Squares*	*df*	*Mean square*	*F-ratio*	*p-Value*
Between groups	10352.778	3	3450.926	19.671	.000*
Within groups	27367.716	156	175.434		
Total	37720.494	159			

* Statistically significant at 0.05

The results presented in the Table 6 indicates that the posttest mean scores of the experimental groups (E1 and E2) are higher than the posttest mean scores of the control groups (C1and C2).This is attributable to application of jigsaw cooperative teaching strategy to experimental groups. A further analysis using one-way ANOVA test shown in Table 7 indicated that there is a statistically significant difference between the mean scores of the experimental groups and that of the control groups ($P < 0.05$). To show which pairs of groups had significant mean score differences, Scheffe's method of Post HOC tests of multiple comparisons was carried out yielding the results presented in Table 8.

Table 8. Post Hoc Comparisons of the MAT Post-Test Scores for the Four Groups

Learning method (I)	*Learning method (J)*	*Mean difference (I-J)*	*p - Value*
Experimental 1	Experimental 2	-4.21	.559
	Control 1	14.63*	.000
	Control 2	12.60*	.001
Experimental 2	Experimental 2	4.21	.559
	Control 1	18.84*	.000
	Control	16.81*	.000
Control 1	Experimental 2	-14.63	.000
	Control 1	-18.83*	.000
	Control	-2.03	.928
Control 2	Experimental 2	-12.60*	.001
	Control 1	-16.81*	.000
	Control	2.03	.928

The results in Table 8 revealed that there is a statistically significant difference in mean scores between the experimental groups and control groups. The results also indicated that there is no statistically significant mean score difference between the two experimental groups or the two control groups. That is, the mean difference between E1 and C1 and E2 and C2, was statistically significant ($P < 0.05$). But the mean difference between E1 and E2 ($P = -4.21$) and C1 and C2 ($P=-2.03$) was not statistically significant.

The main threat to the internal validity of non-equivalent control group experiments is the possibility that the group differences on the post-test may be due to initial or pre-existing group differences rather than to treatment effect (Gall et al., 1996). Since this study involved non-equivalent control groups it was necessary to confirm the above results by performing analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) mathematics scores as the covariate. ANCOVA reduces the effects of initial group differences statistically by making compensating adjustments to post-test means of the groups involved (Gall et al., 1996; Borg and Gall, 1989). The adjusted students post tests MAT mean scores are shown in Table 9

Table 9. The Adjusted Students' Post-Test MAT Means Scores using KCPE Mathematics Scores as the Covariate

Learning method	*Mean*
Experimental 1	27.56
Experimental 2	34.94
Control 1	15.17
Control 2	16.76

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The adjusted students' post-test MAT mean scores were then compared using ANOVA to find out if there were any statistical significant difference at ά = 0.05 level.

Table 10. ANCOVA results of the Post-test adjusted Mean Scores on the MAT

Source	*Sum of squares*	*Df*	*Mean Square*	*F-ratio*	*p-Value*
Contrast	10352.778	3	3469.067	24.212	0.000*
Error	27367.716	153	143.277		

* Statistically significant at 0.05

The ANCOVA post- test results of adjusted MAT mean scores shown in Table 10 indicate that

there was a statistically significant difference between mean scores of both experimental groups when compared to each of the control groups. However these results do not give us differences between specific pairs of groups. Hence there was need for further analysis using multiple pos-hoc comparisons test which yielded the results shown in table 11.

Table 11. Multiple comparison of the Students' Post-test adjusted MAT Scores

Learning method (I)	*Learning method (J)*	*Mean difference (I-J)*	*p - Value*
Experimental 1	Experimental 2	-7.38*	.008
	Control 1	12.39*	.000
	Control 2	10.80*	.000
Experimental 2	Experimental 2	7.38*	.000
	Control 1	19.77*	.000
	Control	18.18*	.000
Control 1	Experimental 2	-12.39*	.000
	Control 1	19.77*	.000
	Control	-1.59	.559
Control 2	Experimental 2	10.80*	.000
	Control 1	-18.18*	.000
	Control	1.59	.559

*Statistically significant at 0.05

The results shown in Table 11 also indicated that there is a significant difference between the experimental groups and the control groups (P<0.05) but no significant difference between the control groups. Therefore, the hypothesis suggesting that there was no statistically significant difference in students' Mathematics achievement between students who are taught mathematics using Jigsaw cooperative learning strategy and those taught using conventional teaching method was rejected. However there was also a noted significance difference in adjusted mean scores between E1and E2 which was unexpected. This could be attributed to the fact that E2 was a boarding school while E1was a day school. Generally boarding schools have better performance in academic subjects than day schools at national examinations in Kenya.

DISCUSSION

Students taught mathematics through the Jigsaw cooperative learning strategy performed significantly better than those who were taught through the conventional or traditional teaching methods. These findings support earlier studies that concluded that the use of the

Jigsaw cooperative learning strategy improved achievement scores compared to the conventional teaching methods (Hanze & Berger, 2007). The results further confirm Burns` (1984) assertion that Jigsaw cooperative learning strategy results in higher learners` achievement because they engage in challenging tasks in their expert groups with enthusiasm because they know they have to convey the information when they move back to their respective home groups. The Jigsaw cooperative learning strategy makes learning interesting, it is highly interactive, students actively learn, and encourages students' responsibility in learning (Baird & White, 1984). This is necessary in order for them to develop a variety of problem solving techniques and to transform what they have learnt for better use.

Cooperative learning enhances social interaction which is essential to meet the needs of students and maintains trust among them (Slavin, Leavy, &Madden, 1989; Goodwin ,1999).Team names also in this study gave a sense of belonging and this ensured competition between teams rather than between individual students. Students assisted one another in the learning process and it was the duty of each member to make sure that other group members had mastered the concepts learnt in expert groups. The high achievers and low achievers learnt together because the activities required teamwork to accomplish. Each type of classroom reward structure in this learning arrangement promotes a different pattern of interaction among students (D'amico & Schumid, 1997).The cooperative structure in this study resulted in better achievement in the mathematics topics than the competitive and individualistic structures found in mathematics classrooms. It would be desirable therefore to implement this strategy in secondary school mathematics teaching.

CONCLUSION

Based on the findings of this study, which was carried out in District mixed-sex secondary schools of Laikipia East District of Kenya , it was concluded that students who are taught mathematics topics using Jigsaw learning strategy perform better in the topics than those taught by use of conventional teaching methods.

IMPLICATIONS

The use of Jigsaw learning strategy in teaching results in better students' performance in mathematics. The Jigsaw learning strategy is therefore a suitable method for teaching. School Quality Assurance and Standards Officers in education should encourage teachers to use this strategy of teaching mathematics in order to improve the current trend of dismal performance in mathematics worldwide and especially in District schools of Kenya. The teacher training colleges and universities should emphasize Jigsaw learning strategy as an effective method of teaching mathematics.

RECOMMENDATIONS

It is recommended that Jigsaw learning/teaching strategy be incorporated in teacher education programs, in-service courses for mathematics teachers, and that the strategy be practiced in mathematics classrooms.

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REFERENCES

Aronson, E. (2000). *Nobody left to hate Developing the emphatic Schoolroom.* The Humanist, 60, 17-21.

Baird, J. & White, R. (1984) "*Improving learning through enhanced metacognition*: A classroom study", Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA 1984

Borg, W. R. & Gall, M. O. (1989). *Educational research*: An introduction, 5th Edn. Longman, White Plains, N.Y.

Burns, M. (1984). "*The Math Solution*". Marilyn Burns Education Associates publishers, reprinted in "Cooperative Learning in Mathematics" Neil Davidson editor, 1990

Cohen, E. (1992). Restructuring the Classroom: Conditions for productive small groups.Madison*, Wisconsin center for Education Research*, 1992. ed 347 639.

D'amico, M. & Schumid, R. F. (1997). *Psychology Applied to teaching* (8th ed). New York, NY: Houghton Miffin Company.

David & Johnson, R. (2001) "*An Overview of Cooperative Learning.*" [Online] Available: <http://www.clcrc.com/pages/overviewpaper.html>2 December 2010.

Gall, M. D., Gall. J. P. & Borg, W. R. (1996). *Education Research:* An Introduction (7th ed) New York: Person Education Inc.

Goodwin M.W. (1999). Cooperative Learning and Social Skills to Teach and how to Teach them. *Interventions in School & Clinic,* 35, 29-34.

Hanze, E. & Berger, W. (2007). "Restructuring the classroom: Conditions for productive small groups", *Review of Educational Research* Spring 1994 vol. 64 pp1-35

Johnson, D. W., Johnson, R. T. & Holubec, E. J.(1993). *Circles of learning: Cooperation in the Classroom*, 4th edition. Interaction book.

Kenya National Examinations Council (2010). *KCSE Mathematics reports in Kenya.* Nairobi, Kenya: Government Printers

KIE (2000-2007). *Examination report*, Vol 1. Kenya Institute of Education, Nairobi, Kenya.

Mugenda, M. O. & Mugenda, A. G. (1999). R*esearch methods. Qualitative and quantitative approaches*. Nairobi, Kenya: CTS Press.

Neer, M. R. (1987). "*The development of an instrument to measure classroom apprehension*", Communication Education 36, pp154-166.

O' connor, M. (2000). *The open-ended approach in mathematics Education*. Nairobi; Kenya SMASSE Project.

Ogunniyi, B. M. (1996). Science, Technology and Mathematics. The Problem of Developing Critical Human Capital in Africa. *International Journal of Science Education*, 18(3). 284.

Opolot-Okurot, C. (2005). Student attitudes toward mathematics in Uganda Secondary Schools. *African Journal of Research in Mathematics, Science and Technology Education,* 9 (2). 167-174.

Panitz, T. (1996). "*Getting students ready for cooperative learning*", Cooperative learning and College Teaching, v6 N2, winter 1996.

Prater, M. A., Bruhl, S. & Serna, L. A. (1998). Acquiring Social Skills through Cooperative Learning and Teacher-Directed Instruction. Remedial and Special Education, 19, 160-172. *Review of Research in Education;* 8, 158-223. Federal Republic of Nigeria 2004: National Policy on Education (Revised). NERC.

Slavin, R. E. (1997). *Educational Psychology: Theory and practice* (5th ed).Boston: Allyn and Bacon.

Slavin, R. E. (1991). *Student Team Learning: A practical guide to Cooperative learning.* Washington, DC: National Education Association, 339 518.

Slavin, R. E., Leavy. N. L. & Madden, N. A. (1989). *Effective Programs for Students at Risk.* Boston: Allyn and Bacon.