ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2 No. 2 May 2013

# EFFECTS OF COOPERATIVE LEARNING/ TEACHING STRATEGY ON LEARNERS` MATHEMATICS ACHIEVEMENT BY GENDER

**Joseph Njogu Njoroge [1], Bernard Nyingi Githua [2]**

[1] Ministry of Higher Education Science and Technology, &
[2] Department of Curriculum, Instruction and Education Management, Egerton University, KENYA.

[1] njorogenj@gmail.com , [2] bgithua2002@yahoo.com

## ABSTRACT

*Due to the high value attached to mathematics globally, the study of mathematics is compulsory in all primary and secondary schools in Kenya. However, students` performance in the subject worldwide and at Kenya certificate of secondary education (KCSE) examination is dismal with marked gender difference. Students have continued to perform poorly in certain mathematics topics due to ineffective teaching strategies practiced by mathematics teachers. One such topic is scale drawing taught to 14 year old form one students in secondary schools in Kenya. This study sought to determine the effects of Students Teams -Achievements Divisions, Co-operative Learning (STAD, CL) teaching strategy on students' mathematics achievement in scale drawing topic by gender. A simple random sample of four co-educational district secondary schools in Nakuru District was obtained. The study was carried out in a mathematics classroom setting. Solomon four group designs under quasi-experimental research was used. The two experimental groups were taught using co-operative learning strategy as treatment and two control groups were taught by use of conventional teaching methods. The sample size was 323 students comprising 161 boys and 162 girls. A mathematics achievement test (MAT) in scale drawing had a reliability coefficient of 0.84 .The MAT was administered to two groups (E1and C1) before the teaching of the topic and then to all the four groups after learning the topic, scale drawing. The t and ANCOVA tests were used to test the hypothesis at 0.05 significance level. The results indicated that there were no gender differences in students` mathematics achievement after their being taught scale-drawing topic through STAD, co-operative learning strategy. It was recommended that STAD co-operative learning strategy be included in the syllabus for pre-service and in-service teacher education programs and be used by mathematics teachers during instruction.*

**Keywords:** STAD, Co-operative Learning; Mathematics Achievement; Gender

## INTRODUCTION

Mathematics is perceived as an important academic subject to society globally (Cockcroft, 1982, Githua, 2002, Ndimbirwe, 1995). The reason for this is due to the fundamental role it plays in modern scientific and technological developments (Cockcroft, 1982, Costello, 1991). Despite this, learners' performance in the subject at the national examinations in many countries has remained below average (Costello, 1999; KNEC, 2008) and with significant gender differences in favor of boys (KNEC, 2011; Burton, 1996). The Kenya Certificate of Secondary Education ( KCSE ) mathematics examination results for example for the years 2007 and 2006 revealed that students had low national mean scores of 19.73 % and 19.04 % respectively (KNEC, 2008, 2007).

Several factors have been cited as general causes of the poor performance in mathematics. These include: ineffective teaching methods (Miheso, 2012; Zakaria and Iksan, 2007); unavailability of teaching materials; its specialized language; and symbolism used in the subject (Akala, 2000).

Even with such students` dismal performance in the subject, female students have had lower achievement as compared to male students at national mathematics examinations in Kenya. For instance in the year 2007, girls obtained an average of 15.74 % while boys had 23.10 % (KNEC, 2009). Such an underachievement has been attributed to, gender biased mathematics text books, competitive modes of assessment in favor of boys, cultural view of mathematics as a male domain, lack of positive female role models in mathematics and modes of teaching that are individualistic or competitive, as opposed to being co-operative (Githua, 2002 ; Ndimbirwe, 1995; Agwagah and Harbour-Peters 1994).

The commonly used teaching and learning approaches in mathematics in Kenya's secondary schools and other parts of the world are teacher centered (Oyaya& Njuguna, 1999; Zakaria and Iksan, 2007) which are ineffective. In this study STAD (CL) teaching strategy which is student-centered, was used in a mathematics classroom setting and its effects on learners` achievement in the scale drawing topic of mathematics studied by gender .A comparison of learners` mathematics achievement by gender was analyzed. The mathematics topic was selected among those that are poorly performed at KCSE national examinations (KNEC, 2010).

STAD CL is a strategy of instruction whereby students work together in groups of varying composition to achieve common objectives. To be successful in this strategy, students share ideas rather than working alone and assist one another in order to maximize mutual benefits. (Slavin, 1997; Johnson& Johnson, 1989). This is unlike the use of conventional teaching methods where students work individually or competitively (Slavin, 1997).

An analysis of 67 studies conducted on effects of the co-operative learning on learners` achievement in different subjects in school curricula indicated that, 61% of them found significantly greater achievement with learners taught by use of cooperative learning than in traditionally taught control groups (Slavin, 1991). The positive results were found in all major subjects, all grade levels, in urban, rural and sub-urban schools, and for high, average, and low achievers (Slavin, 1991).This study was to find out whether similar results obtain on students` mathematics achievement in Kenyas` secondary schools by gender.

There are several models used in CL categorized on the basis of group composition, organization and duration of study (Slavin, 1995). This study used the fundamentals of the Students Teams-Achievement Divisions (STAD) cooperative learning Strategy as recommended by Slavin (1997) .Students` teams comprised five to six students .STAD CL is most appropriate for teaching subject matter with well-defined objectives such as mathematics (Postlethwaite and Husen, 1994; Slavin, 1997). In this strategy the teacher presented the mathematics lesson first and then students' teams used a variety of methods to master the material, such as quizzing each other, discussing and using worksheets. To recognize team members` excellent performance scores were computed on the basis of team members' improvement scores, after which certificates and school bulletin boards were used to recognize high scoring teams. STAD, CL strategy was able to promote face-to-face communication, positive interdependence, individual accountability and interpersonal collaborative skills which were essential in improving the learning of mathematics as recommended by Jonhson, Jonhson and Holubec (1994 ).

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2 No. 2 May 2013

## PURPOSE OF THE STUDY

The purpose of this study was to structure cooperative learning teaching strategy to augment the teaching of scale drawing and then find out whether there are gender differences in students' mathematics achievement in the topic among 15 year old secondary school learners.

## OBJECTIVE OF STUDY

To determine whether there are gender differences in mathematics achievement among students taught through CL teaching strategy.

## HYPOTHESIS OF THE STUDY

The following null hypothesis was tested at 0.05 significance level.

HO1: There are no statistically significant gender differences in mathematics achievement among students taught scale-drawing topic through CL teaching strategy.

## CONCEPTUAL FRAMEWORK

This study was guided by the principles of cooperative learning, that are supported by social inter-dependence theory which holds that groups are dynamic wholes in which the inter-dependence among members could vary (Johnson & Johnson, 1989). According to Deutsch (1949) and Johnson and Johnson (1989), social interdependence exists when individual's outcomes are affected by the actions of others.

Such inter-dependence tends to result in enhanced interaction, a situation where the actions of one student substitute for the actions of another. Such interaction tends to result in a wide variety of outcomes such as learners` high effort to achieve, positive relationships and psychological health. Learners mutually influence one another's reasoning and actions; engage in interpersonal and small group skills that contribute to effective teamwork (Johnson & Johnson, 1989; Kagan, 1993; Slavin, 1997).

Informed by this theory, the interaction of variables of the study was conceptualized as shown in figure 1.

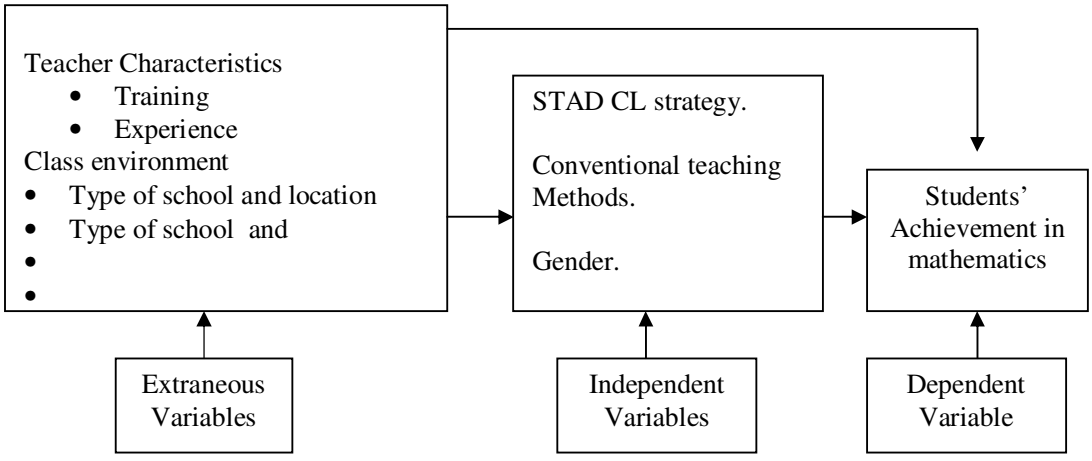


Figure 1. Conceptual framework showing the relationship of the variables of study

The independent variables included STAD CL teaching strategy, conventional teaching / learning methods and gender. These variables were conceptualized as factors influencing the dependent variable of the study that is, students' mathematics achievement. Teachers'

characteristics as well as the class environment were the extraneous variables, which could influence the teaching, learning process and mathematics achievement as shown in figure 1. Learners' age was controlled by selection of form one 14 year old students. Trained teachers with teaching experience of three years and above were used to control for teacher characteristics. Selection of co-educational schools in rural set up controlled for the type of school and location.

## RESEARCH METHODOLOGY

The design used in this study was Solomon IV group under the quasi experimental research.

The study involved four groups as shown in Figure2.

| GROUP | NOTATION | | |
|---|---|---|---|
| E1 | $O_1$ | $XO_2$ | (Experimental group) |
| C1 | $O_3$ | _ | $O_4$ (Control group) |
| E2 | _ | X | $O_5$ (Experimental group) |
| C2 | _ | _ | $O_6$ (Control group) |

Figure 2. Solomon IV Group Design under Quasi-Experimental Research

In figure 2, the variables are defined such that: O1 and O3 are pre- tests; O2, O4, O5 and O6 are post tests; X is treatment. Group E1 received pre-test, X and post-test; Group C1 received a pre-test and post-test; Group E2 received X and post-test and group C2 received the post-test only. This design was suitable in achieving three purposes according to Gall, Borg & Gall, (1996) which are: assessing the effects of the experimental treatment in relation to control, determining the effects of pre-test, and assessing the interaction between pre-test and treatment conditions.

Mathematics Achievement Test (MAT) was used for post-test in the study. The treatment (X) was Student Team-Achievements Division Cooperative Learning (STAD, CL) teaching strategy. In this strategy mathematics teachers in experimental schools used past learners' performance to constitute teams of five to six members based on mixed ability gender and ethnicity.

To achieve the objectives of teaching and learning 'scale drawing' topic in KCSE mathematics syllabus (KIE, 2002), teachers in the experimental schools were expected to follow a guideline provided by the researchers, which was aimed at ensuring uniformity of treatment. The control Groups (C1 & C2) were taught through the conventional teaching methods. The topic was taught at the same time to all the groups to ensure uniformity and comparability of results.

### Population of the study

The target population of this study was Form One 14 year old students enrolled in district secondary schools of Nakuru District. However, the accessible population for this study was Form one14 year old students enrolled in co-educational district secondary schools. The study focused on district schools because they are the majority (80%) in Kenya (NDES,

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2 No. 2 May 2013

2005). Co-educational District secondary schools were studied because gender was one of the variables of interest in the study.

**Sampling Procedure and Sample Size**

The researchers purposively selected schools with two form one streams and above from a list of co-educational district secondary schools in Nakuru district. Four schools, E1, C1, E2 and C2 were randomly selected from the list and then randomly assigned to 2 experimental and 2 control groups as required by quasi-experimental Solomon Four Group Design. If a selected school assigned to an experimental group had more than two classes, all the students were exposed to the treatment but two streams each were randomly selected for analysis. According to Mugenda & Mugenda (1999) at least 30 subjects per group is suitable for experimental research. The single classes used for the exercise in the four schools had between 35 and 45 students each and the actual sample size obtained for double streams in the four schools was 323. This consisted of 161 male and 162 female students. The experimental groups had 85 male and 89 female students while control groups had 76 male and 73 female students on which analysis was conducted in the study.

**Instrumentation**

The mathematics achievement test (MAT) comprising 10 unstructured questions that tested knowledge, comprehension and application of all skills of the 'scale drawing' topic was used in the study. The maximum score for the test was 70 marks. The instrument was validated by five experts in mathematics education for face and content validity. Its reliability was estimated to be 0.8402 Cronbach`s coefficient alpha. This was above the threshold of 0.7 which is considered suitable to make possible group predictions that are sufficiently accurate (Gronlund, 1981).

**How STAD, CL was Sstructured and In- built in lessons**

The two experimental schools E1and E2 were exposed to STAD, CL when learning the scale drawing mathematics topic as contained in the syllabus (KIE, 2002). The subtopics included: Types of scales; Conversion of scales; Choice of scales; Drawing sketches and accurate plans; Bearings and direction; Angle of elevation and depression; Use of simple clinometer, theodolite and surveying techniques. Trained teachers with a teaching experience of three years and above participated in the study. Participating teachers in experimental schools were trained for one week when schools were in recess after which the students in the experimental schools were introduced by their teachers to the STAD, CL strategy as contained in the teachers' guide without disclosing to them that they were an experiment. The teaching guide contained the general STAD, CL procedures, elements of cooperative learning, team scores computation procedures, group and individual rewards, breakdown of subtopics in scale drawing, teachers` and learners` activities, resources and references. The guide assisted in having similar treatment in the experimental schools.

Teachers in the experimental schools used past mathematics performance record to constitute heterogeneous teams of five to six members which were given time to decide on team name for identity. The steps of STAD CL strategy (Slavin, 1997) were followed as was stipulated in the teachers' guide. The cycle of instructional activities included: Lesson presentation; Team study, where students worked on worksheets in their teams to master the material; Evaluation, where students took individual quizzes. Finally, team recognition where team scores were computed on the basis of team members' improvement scores. The results were displayed on school bulletin board every week and at the end of the topic certificates were awarded to the high scoring teams.

The five critical elements of cooperative learning (Johnson, Jonhson and Holubec,1994) were observed. When working in groups the teams sat in circles thereby promoting face to face communication. The goal structure required that all group members attain at least 70% in the quizzes and the joint reward ensured positive interdependence. Individual accountability was achieved through the quizzes that were taken without help. To develop interpersonal and group skills the teams were encouraged to communicate accurately and unambiguously, accept and support each other and were able to solve their conflicts constructively. After every quiz results, group members were given time to discuss how well they achieved their goal to ensure group processing.

## RESULTS

The hypothesis of the study investigated whether there are gender differences in mathematics achievement after students were taught the mathematics topic of scale drawing by use of STAD CL .The t-test and ANCOVA were used to analyze post-test data. Table 1 shows the t-test results of post-test MAT scores by gender.

**Table 1. Independent sample t-test of the post-test MAT scores of male and boys exposed to cooperative learning strategy**

| *Gender* | *N* | *Mean* | *SD* | *Df* | *T* | *P-value* |
|---|---|---|---|---|---|---|
| Male | 85 | 36.34 | 12.11 | 172 | 3.65 | 0.00 |
| Female | 89 | 30.04 | 10.66 | | | |

The results in Table 1 indicates that the difference in MAT post test mean scores between male and female students was statistically significant, t (172) =3.65, $p<0.05$ with male students having higher mean score than female students. Table 2 displays the observed and the adjusted post test MAT mean scores of experimental groups by gender. Table 3 shows the corresponding ANCOVA results.

**Table 2. Observed and Adjusted MAT post-test mean scores of experimental groups by gender**

| *Gender* | *N* | *Observed Mean* | *Adjusted Mean* |
|---|---|---|---|
| Male | 85 | 36.34 | 34.40 |
| Female | 89 | 30.03 | 31.88 |

**Table 3. Analysis of Covariance of the post-test MAT scores of male and female students exposed to STAD, CL with K.C.P.E mathematics scores as covariate**

| | *Sum of squares* | *Df* | *Mean squares* | *F* | *P – value* |
|---|---|---|---|---|---|
| K.C.P.E | 6753.55 | 1 | 6753.55 | 74.21 | 0.000 |
| GENDER | 252.51 | 1 | 252.51 | 2.78 | 0.098 (ns) |
| ERROR | 15562.46 | 171 | 9101 | | |
| TOTAL | 22568.52 | 173 | | | |

ns – Not significant at 95% confidence level.

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2 No. 2 May 2013

An examination of Table 3 revealed that, when initial differences were taken aboard by use of ANCOVA with KCPE mathematics scores as covariate, the differences between male and female students on achievement were not statistically significant F(1,171)=2.78,p=0.098, p>0.05.This implied that use of STAD CL removes gender differences in learners` mathematics achievement .

A further analysis of post test MAT scores using a t-test and ANCOVA was carried out to compare male and female students` mathematics achievement in the control groups. This was done to determine whether teaching and learning through the conventional teaching methods had similar achievement effect as teaching through STAD, CL strategy. Table 4 shows the *t* - test results.

**Table 4. T- test of post- test MAT scores of the control groups with regard to gender**

| Gender | *N* | Mean | *SD* | *Df* | *T* | *P*-value |
|---|---|---|---|---|---|---|
| Male | 75 | 11.68 | 6.57 | 146 | 2.081 | 0.039 |
| Female | 73 | 9.74 | 4.57 | | | |

The t- test results indicate that the difference in MAT post test mean score of male and female students in control groups were statistically significant, $t(146) = 2.081$, $p < 0.05$, with male students having a higher score.

A further analysis of covariance was carried out to account for initial difference that may have existed between male and female students in the control conditions. Table 5 shows observed and adjusted post-test mean scores in the control groups by gender.

**Table 5. Observed and adjusted MAT post test mean scores of control groups by gender.**

| Gender | *N* | Observed mean | Adjusted mean |
|---|---|---|---|
| Male | 75 | 11.68 | 11.361 |
| Female | 73 | 9.74 | 10.067 |

**Table 6. ANCOVA of the post test MAT scores of male and female students in the control groups with KCPE mathematics mean scores as covariate.**

| | Sum of squares | *Df* | Mean squares | *F* | *P* – value |
|---|---|---|---|---|---|
| K.C.P.E | 1163.371 | 1 | 1163.371 | 46.966 | 0.000 |
| Gender | 61.987 | 1 | 61.987 | 2.583 | 0.013 |
| Error | 3552.263 | 145 | 25.407 | | |
| Total | 4855.647 | 14 | | | |

Analysis of covariance in Table 6 revealed that the differences in mathematics achievement between male and female students in control groups that were taught through the conventional teaching methods were statistically significant, $f(1,145) = 2.583$, $p<0.05$. This arrangement maintained significant gender differences in mathematics achievement for the topic scale drawing.

The hypothesis of study that there is no statistically significant gender difference in mathematics achievement of students who learnt through STAD, CL teaching strategy was therefore retained. This implied that, male and female students who learnt through STAD CL teaching strategy performed equally well in mathematics while male and female students who learnt through the conventional methods performed differently with male students attaining higher scores.

## DISCUSSION

### Effect of Cooperative Learning on Girls' and Boys' Mathematics Achievement

The findings of this study showed that there was no statistically significant gender difference in mathematics achievement for students who were taught through STAD, CL teaching strategy. Therefore the STAD, CL strategy proved to be more effective in enhancing mathematics achievements for male and female students than the conventional teaching methods.

STAD, CL teaching strategy proved better in removing the gender differences gap in students`mathematics achievement. This is probably because teachers changed their role of active teaching to that of supervising, clarifying concepts and organizing the learning process. Earlier research by Wachanga (2002) in Kenya in support of this study indicated that cooperative learning in co-educational secondary schools, despite improving achievement in chemistry for both boys and girls; it favored girls more than the boys. However, in this study both boys and girls seemed to benefit equally while learning mathematics cooperatively. Therefore gender difference in achievement at KCSE mathematics examinations can be minimized by using cooperative learning/ teaching strategy in mathematics classrooms

## CONCLUSIONS

Based on the results of the study, it was concluded that there are no gender differences in students' mathematics achievement when students are taught using cooperative learning/ teaching strategy.

## IMPLICATIONS OF THE STUDY

The use of cooperative learning in teaching mathematics minimizes gender differences in students' achievement in mathematics. Cooperative learning/teaching strategy is therefore a suitable teaching/learning strategy for use in mathematics classrooms. Teacher training colleges and universities should emphasize cooperative learning as an effective strategy of teaching mathematics. Education stakeholders should encourage teachers to use this strategy in teaching mathematics so that students share their intellect, co-exist harmoniously, and learn without anxiety and enjoy mathematics lessons.

## RECOMMENDATIONS

Mathematics educators in colleges and universities should incorporate cooperative learning teaching strategies in their teacher education programs, in-service courses and that the strategies be practiced by teachers in mathematics classrooms as part of an overall strategy to reduce gender differences in mathematics achievement.

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 2 No. 2 May 2013

## REFERENCES

Agwagah,U.N.V. & Harbour-Peters,V.F. (1994). Gender Difference in Mathematics Achievement. *Journal of Education and Psychology in Third World Africa, 1*(1), 19-22.

Akala, J. (2002). *The agony of teaching mathematics*, Kenya Times, pp.16-1.

Cockcroft, W.H. (1982). *Mathematics Counts: The Committee Inquiry into the Teaching of Mathematics in Primary, Secondary Schools in England and Wales.* London: DES/HMSO.

Bargh, J. & Schul, J. (1980). The cognitive Benefits of Teaching, *Journal of Educational Psychology, 72*(5), 593-604

Burton,L.(1996).*Gender and Mathematic*s:An interpersonal Perspective.London.:Cassel

Costello, J. (1991). *Teaching and learning mathematics*. London: Routledge, Chapman & Italy Inc.

Duetsch, M. (1949). A Theory of Cooperation and Competition. http://www.clare.comp/pages/stt.html

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

Githua, B.N. (2002). *Factors Related to the Motivation to Learn Mathematics Among Secondary School Students in Kenya's Nairobi Province and Three istrict of Rift Valley Province.* Unpublished, Doctoral thesis, Egerton University Njoro. Kenya.

Gronlund. N. E. (1981). *Measurement and Evaluation in Teaching* (4th Ed.). New York: Macmillan publishers Co., Inc.

Johnson, D.W. & Johnson, R.T. (1989). Cooperative Learning and social Interdependence. http://www.clare.com/pages/STT.html

Jonhson, D. W., Jonhson, R.T. & Holubec,E. J.( 1994).Cooperative Learning in the Classroom. VA: Association for Supervision and Curriculum Development.

Johnson, D. W., Johnson, R. T., & Stanne, M. B. (2000). Cooperative Learning Methods: A Meta Analysis. Available, http://www.clare.com/pages/cl-methods.html,cited, *July, 2000.*

Johnson, G. M. ( 1998). Principles of Instruction for At-Risk Learners. *Preventing School Failure,* (42), 167-181.

Kagan, S. (1993). *The Structural Approach to Cooperative Learning*, in Cooperative Learning:A Response to Linguistic and Cultural Diversity. Washington, D.C.: Delta Systems and Centrer for Applied Linguistics.

Kenya Institute of Education (KIE), (2002). *Secondary Education Syllabus* (Vol.2). Nairobi: Kenya Literature Bureau.

KNEC (2011). The year 2011 examination newsletter. Nairobi KNEC

KNEC (2010). *KCSE examination reports, 2010*. Kenya National Examinations Council, Nairobi, Kenya.

KNEC(2009). *KCSE examination reports, 2009*.Kenya National Examinations Council Nairobi, Kenya.

KNEC (2008). *KCSE examination reports, 2008*. Nairobi, Kenya: Kenya National Examinations Council,

KNEC (2007). *KCSE examination reports, 2007*. Nairobi, Kenya: Kenya National Examinations Council.

Miheso,K.M.(2012).`Factors affecting mathematics performance among secondary school students in Nairobi province Kenya` unpublished PhD thesis Kenyatta University http://ir-liblary.ku.ac.ke/etd.handle/123456789/2485

Mugenda, M.O. & Mugenda, G. A. (1999). *Research Methods; Quantities and Qualitative Approaches*. Nairobi (Kenya): CTS Press.

Nakuru District Education Statistics (NDES), (2003).*Secondary School Statistics*. Nakuru District Education Office, Kenya

Ndirimbwe, J.B. (1995). *Factors Causing Underachievement in Mathematics among Secondary School Girls in Zambia*. Abridged Report No. 7. Nairobi,Kenya: Academic of Science Publishers.

Oyaya, E. O.& Njuguna, B.M. (1999). *Strengthening Mathematics and Science at Secondary Education* (SMASSE). A paper presented to Kenya National Heads Associations Conference, Mombasa, Kenya.

Postlethewaite, T. N. & Husen, T. (1994). Cooperative learning. In: *The International Encyclopedia of Education* (vol. 8, pp. 1095-1099). New York: Elsevier Science Ltd.

Saye, D. & Abbott, T. (2000). Successful Experiences and Outcomes of Cooperative Learning. http://www.umke.edu/cad/nade/nadedocs/94conpap/dscpap94.htm

Slavin, R. E. (1991). Synthesis of Research on Cooperative Learning. *Educational Leadership, 48,* 71-82

Slavin, R.E. (1995).*Cooperative Learning: Theory, Research and Practice*. Boston: Allyn and Bacon.

Slavin, R. E. (1997). *Educational Psychology: Theory and Practice* (5th Ed.). Boston: Allyn and Bacon Company.

Wachanga, W. S. (2002). *Effects of Cooperative Class Experiment Teaching Method on Secondary school students' motivation and Achievement in Chemistry*. Unpublished, Doctoral Thesis, Egerton University, Kenya

Zakaria, E. & Iksan, Z. (2007).Promoting Cooperative Learning in Mathematics Education: A Malaysian Perspective. *Eurasian Journal of Mathematics, Science & Technology Education, 3*(1), 35-39