EFFECTS OF TEAMS - GAMES - TOURNAMENTS COOPERATIVE LEARNING ON STUDENTS' MATHEMATICS ACHIEVEMENT IN PUBLIC SECONDARY SCHOOLS IN NYERI CENTRAL SUB-COUNTY, KENYA

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ABSTRACT

This study investigated the effects of using Teams-Games-Tournaments Cooperative Learning Strategy (TGTCLS) on Students' Mathematics achievement. Quasiexperimental Solomon Four Non-Equivalent Control Group Design was used in the study. The target population was all secondary school students in Nveri Central Sub-County. The accessible population was all form two students in the Sub-County. Simple random sampling was used to select four Sub-County public secondary schools. A sample of 180 form two students participated in the study. The study focused on the topic Similarity and Enlargement. This is one of the topics students perform poorly at the Kenya Certificate of Secondary Education examination. Two experimental groups (E1 and E2), were taught using Teams-Games-Tournaments Cooperative Learning Strategy as treatment while two control groups (C1 and C2), were taught using the conventional teaching methods (CTM). Mathematics Achievement Test (MAT) was used to collect data. Prior to the study, MAT was validated by four experts from the Department of Curriculum, Instruction and Education Management of Egerton University and three secondary school Mathematics teachers. MAT was administered to E1 and C1 before intervention and then to the four groups after intervention. Findings of this study show that learners in the experimental groups performed better than those in the control groups. It is recommended that secondary school teachers and students be encouraged to apply Teams-Games-Tournaments Cooperative Learning Strategy during the teaching and learning of mathematics in order to improve students' mathematics achievement. Curriculum developers and implementers are likely to benefit from this study in deciding on the appropriate learning strategy in order to improve mathematics performance. It is further recommended that teacher training colleges and universities should emphasize on Teams-Games-Tournaments Cooperative Learning Strategy as an effective method of teaching mathematics in the course of training of mathematics teachers.

Keywords: Teams-Games-Tournaments Cooperative Learning, Mathematics Achievement

INTRODUCTION

Mathematics is an essential discipline that is recognized as a tool for solving everyday problems faced by individuals. Mathematics as such is an important subject as knowledge of it enhances a person's reasoning, problem-solving skills, and the ability to think (Ogan, 2015). Its importance to human existence cannot be overemphasized in view of its application to everyday life activities (Sunday et al., 2014). Dambatta (2013) posit that knowledge of mathematics allows scientists to communicate ideas using universally accepted language since it is truly the language of sciences.

Despite the significance of mathematics in society, students' performance in the subject has been dismal. According to Organization for Economic Cooperation and Development (OECD, 2016), students' achievement in mathematics has been persistently poor globally. OECD in the analysis of the Programme for International Students Assessment (PISA, 2015) mathematics results noted that out of the over seventy countries and education systems that were assessed, only nineteen countries scored above the score of 500 out of 1000. The average score for all the countries was 490. The best country was Singapore with a score of 564 followed by China with 548 and Japan with 532. United States of America, England and Germany scored 470, 492 and 506 respectively. Among the African countries that participated, Tunisia was the best with a score of 367 in position 66. This would imply that mathematics performance in Africa is far below world class standards. Algeria had a score of 360 in position 69 which was among the lowest in the World.

Aburime (2009) and Amoo (2001) as cited by Githua and Mwangi (2013) have expressed concerns about the low achievement in mathematics in Nigeria. In South Africa, Mji and Makgato (2006) identified factors that influence learners' poor performance as: ineffective teaching strategies, lack of basic content knowledge and understanding on the side of the teachers, lack of motivation and interest of the learners, non-completion of the syllabuses and lack of parental involvement.

In Kenya students' performance in mathematics at the Kenya Certificate of Secondary Education (KCSE) examinations from 2011 to 2017 revealed that the students' performance nationally was consistently low as shown in Table 1.

Tuble 1.	Repe ma	incinatios	rereentag	e mean s	cores (20	11 2017)	
Year	2011	2012	2013	2014	2015	2016	2017
Grand Mean%	24.79	28.66	27.58	24.02	26.88	20.78	25.48

Table 1 [.] KCSI	E Mathematics	Percentage Mean	Scores	(2011 - 2017)
Table 1. KCSI		i ci centage mican	Scores	(2011-2017)

Source: Keny	a National	Examination	Council	(KCSE 2011-2017	7) Reports

Table 1 indicates that between 2011 and 2017, mathematics examination results were generally poor hence there is need for intervention so as to improve the performance. The persistent poor performance in mathematics was also registered in Nyeri Central Sub-County as shown in Table 2.

 Table 2: Students' Mathematics Performance Indices at KCSE (2011-2017) in Nyeri Central

 Sub-County

Year	2011	2012	2013	2014	2015	2016	2017	
Index	4.951	5.597	4.870	4.960	4.950	2.867	3.258	

Source: Nyeri Central Sub-County Education Office

The students' mathematics mean performance indices represent the mean score of all the students in the entire Nyeri Central Sub-County in the KCSE after the percentage scores of all the students are graded out of the possible twelve points. The mean performance index in mathematics was low and thus there was need to seek effective strategies of instruction to improve students' mathematics performance.

Constructivist learning is one of the recent developments in learning mathematics and science. It is based on students' active participation with emphasis on problem-solving and high-order thinking skills regarding a learning activity that they find relevant and engaging.

Teachers serve as guides, monitors, coaches, tutors and facilitators (Koohang, Riley, Smith & Schreurs, 2009). According to Clements and Batista (2012), mathematical ideas and truths are cooperatively established by members of a culture in which students are involved not only in discovery and invention, but also in a social discourse involving explanation, negotiation, sharing and evaluation.

Cooperative learning is one of the constructivist teaching approaches in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject (David & Roger, 2001). Slavin (2011) defined cooperative learning as an instructional method in which teachers organize students into small groups, and they then work together on structured activities helping one another learn academic content.

Effandi (2005) investigated how cooperative learning affects student achievement and problem solving skills in Malaysia. The study found that cooperative group instruction produced significantly better results in mathematics achievement and problem solving and concluded that cooperative learning methods are a preferable alternative to traditional instructional methods.

Teams-Games-Tournaments (TGT) is a cooperative learning strategy which was originally developed by DeVries and Edwards (1972) at the John Hopkins University. Students compete with members of other teams to contribute points to their team score.

According to Effandi and Zanaton (2007), Teams-Games-Tournaments Cooperative Learning Strategy ((TGTCLS) entails students competing at tables against students from other teams who are equal to them in terms of past performance. Students earn team points based on how well they perform at their tournament tables. Teams-Games-Tournaments Cooperative Learning Strategy involves teams in which students are assigned to equal teams categorized by equivalent academic levels and games where skill exercises relating to content material are played during weekly tournaments. Students represent their teams and compete individually against students from other teams.

Salam et al. (2015) conducted a study on the effects of using Teams-Games- Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Bangladesh. The results of this investigation revealed that there were significant differences in the achievement scores of students who were exposed to TGT as a cooperative learning teaching technique compared to the lecture teaching method.

A baseline survey on the challenging topics in science and mathematics was carried out by SMASSE trainers in Nyeri District in 2007. Findings indicate that the topic "Similarity and Enlargement" was one of the most challenging topics in the form two mathematics syllabus (Nyeri SMASSE, 2007).

The Concepts of 'Similarity' and 'Enlargement' in Mathematics

Two or more figures are similar if the ratio of the corresponding sides is constant and the corresponding angles are equal. Enlargement is when the object and image are similar with a linear scale factor and a point called the centre of enlargement (Kenya Literature Bureau, 2003). The topic "Similarity and Enlargement" is one of the difficult topics to the learners perhaps due to misconception of the terms 'similarity' and 'enlargement'. In the Kenya secondary school cycle, the topic is taught to second grade students and covers the following subtopics: identification and construction of similar figures, stating and applying properties of enlargement to construct objects and images, applying enlargement in Cartesian plane, stating the relationship between linear, area and volume scale factor and applying the scale factors to

real life situations (Kenya Institute of Education, 2002). The topic "Similarity and Enlargement" is poorly performed in Kenya Certificate of Secondary Education examinations. The reports from Kenya National Examinations Council (KNEC) indicate that most candidates were unable to solve problems involving the topic 'Similarity and Enlargement'. Teachers were advised to teach the topic thoroughly and give more practice in the topic for the concepts to be understood clearly (KNEC reports 2012, 2013, 2014, 2015 & 2016).

OBJECTIVE OF THE STUDY

The study was conducted to investigate whether there is any difference in mathematics achievement between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

Hypothesis of the Study

Ho1: There is no statistically significant difference in mathematics achievement between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

Conceptual Framework

This study was guided by Vygosky's theory of the zone of proximal development which holds that the classroom activities should provide a basis of explaining and predicting particular phenomena. The activities should be structured to foster social interaction among group members and this allows students to exchange ideas, experience new behaviors and ultimately internalize these ideas (Doolittle, 1995). The study was also guided by Piaget's theory of constructivist learning which holds that learning is an active process where students are involved in meaningful construction of knowledge (Piaget, 1972). The diagrammatic representation of the conceptual framework showing the relationship between the variables is illustrated in Figure 1.



Independent VariablesExtraneous VariablesDependent VariablesFigure 1: Conceptual Framework showing the Relationship between the Variables

The independent variables are the TGT Cooperative Learning Strategy and the conventional teaching methods. Conventional teaching methods are other teaching methods used in the teaching and learning of mathematics other than TGT Cooperative Learning Strategy. Most conventional methods are teacher-centered, are highly dependent on the skills of the teacher

and do not enhance learner's interpersonal and communication skills. The dependent variable was the students' mathematics achievement. The extraneous variables included the teacher and learner characteristics. Teacher characteristics were in terms of personality, training and experience while the learner characteristics were in terms of student's Mathematics background. Teachers' characteristics were controlled by involving trained teachers with a minimum qualification of a diploma in education and have taught form two class for at least two years (Githua & Mwangi, 2013). To control the learners' background, public sub-county schools were used since they have similar learning environments and the learners have almost similar characteristics in terms of background knowledge and entry behavior (Mutange, 2006).

RESEARCH METHODOLOGY

The study involved a Quasi-Experimental Solomon Four Non-Equivalent Control Group Design. This was because secondary school classes are intact and cannot be reconstituted for research purposes. According to Gall, Gall and Borg (2007), Solomon Four Non-Equivalent Group Design is rigorous enough for experimental and quasi-experimental studies. The design provides effective results for determining cause and effect- relationship. The design helps to assess the interaction between pretest and treatment conditions. It also helps to assess the effect of the pretest relative to no pretest and the homogeneity of the groups before administration of the treatment. Figure 2 illustrates the research design used in the study.

Group	Pretest	Intervention	Posttest
E1	O_1	Х	O_2
C1	O ₃	-	O_4
E2		Х	O_5
C2		-	O_6

Figure 2: Solomon Four Non-Equivalent Control Group Design

Figure 2 shows four groups of subjects that were used in the study. These were: the experimental groups (E1 and E2), the control groups (C1 and C2). Groups E1 and E2 received the treatment (X) which involved being taught using Teams-Games-Tournaments Cooperative Learning Strategy. The Control Groups C1 and C2 were taught using Conventional Teaching Methods. The groups E1 and C1 received a pretest, O_1 and O_3 respectively to ascertain whether or not the groups under study had comparable characteristics. All the groups in this study were subjected to a post-test (O_2 , O_4 , O_5 and O_6) to facilitate comparisons between them.

Target and Accessible Population

The target population was all secondary school students in Nyeri Central Sub-County. The total student population was about 9,357 students. The accessible population was 2510 form two students in public secondary schools (Nyeri Central Sub-County Education office, 2016). Public Sub-County schools were selected because students from these schools represent the population of students with average academic ability.

Sampling Procedure and Sample Size

Simple random sampling was used to select the four schools and this ensured that each school had equal chance of being included in the study sample. Each selected school formed a group

in the Solomon 4 group design. According to Mugenda and Mugenda (2003), at least 30 students per group are required for experimental research. E1, E2, C1 and C2 had 45, 40, 58 and 37 students respectively. The sample size of the study was 180 students.

Instrumentation

Mathematics Achievement Test (MAT) was used to assess students' mathematics achievement. MAT consisted of fourteen items with a maximum score of 60. The test items tested on students' remembering, understanding and applying (Anderson & Krathwohl, 2001). MAT was validated by three secondary school mathematics teachers and four experts in Educational Research in the Department of Curriculum, Instruction and Educational Management, Egerton University. Pilot testing was conducted in the neighboring Tetu Sub-County. Cronbach Alpha Coefficient was used to estimate the reliability. An instrument is deemed to be reliable if the reliability coefficient is at least 0.70 (Gall, Gall & Borg, 2007). MAT was considered reliable since it had a reliability coefficient of 0.850.

Data Collection

Mathematics Achievement Test was first administered to students in experimental group E1 and control group C1 to ascertain their entry level and homogeneity. Experimental groups E1 and E2 were taught the topic 'Similarity and Enlargement' using TGT Cooperative Learning Strategy while groups C1 and C2 were exposed to the same topic using conventional teaching/learning methods. After completion of the topic, all the students in the four groups in the study were subjected to MAT at the same time. Collected data was scored and coded for analysis.

Implementation of Teams–Games-Tournaments Cooperative Learning Strategy (TGTCLS)

The procedure of implementing TGTCLS involved the following eight steps:

Step 1: The experimental groups E1 and E2 were divided into teams of five. E1 with 45 students had 9 teams while E2 with 40 students had 8 teams.

Step 2: The practice version of the test was distributed to each student and instructed to answer the questions cooperatively as a team, ensuring that all team members understood how each answer was obtained. The intention was to lift the overall team performance.

Step 3: Answers to the questions were displayed on the blackboard and each team checked their answers and resolved any issues with their answers.

Step 4: Each team sorted their members on the basis of their understanding of the topic from very good understanding (A students) to poor understanding (E students).

Step 5: Learners were regrouped such that all the A students were made to seat in one area of the room, B students in another area and so on.

Step 6: Test version questions were given to each student and individually answered the questions under formal test conditions.

Step 7: Answers to the test version questions were displayed on the blackboard; each student marked their answers and then ranked themselves amongst the group of students they were grouped with. That is, the five A students ranked themselves from best to worst score such that the best score was given a score of 5 points while the student with the lowest score was given a score of 1 point.

Step 8: The students were made to recombine into their original teams and total their scores with the largest score winning.

According to Awofala, Fatade and Ala-Oluwa (2012), TGT tournaments are held on weekly basis after presentation of content. In this study two tournaments were held fortnightly to allow sufficient time for coverage of the content.

RESULTS

Pre-test Analysis

A pretest analysis was conducted to establish the students' entry behavior by comparing their MAT scores before intervention. According to Gall, Gall and Borg (2007), pre-testing helps a researcher to gather information on the characteristics of the subjects at the beginning of a programme. Independent sample t-test was undertaken to determine whether there was a statistically significant difference between E1 and C1. Table 3 shows the analysis of the results of the pretest.

Table 3. Independent sample t-test of the Pre-test Scores on MAT

Scale	Group	Ν	Mean	SD	Df	t-value	p-value
MAT	E1	45	1.93	2.14	96	.386	.701
	C1	53	1.78	1.70			

The results of Table 3 indicate that the difference between the two means was not statistically significant, t(96) = 0.386, p > 0.05 implying that the two groups E1 and C1 exhibited comparable characteristics and thus suitable for the study.

Effects of TGTCLS on Students' Mathematics Achievement

To determine the relative effect of TGTCLS on students' achievement in mathematics, an analysis of students' post-test scores was carried out. The hypothesis of the study sought to determine whether there was a statistically significant difference in mathematics achievement between students taught using TGTCLS and those taught using conventional teaching methods. The post-test mean scores and standard deviations of the groups are summarized in Table 4.

Group	Ν	Mean scores	Standard Deviation
E1	45	18.91	7.94
E2	40	20.55	8.40
C1	53	14.94	4.31
C2	37	14.12	5.63

Table 4. MAT Post-test Mean Scores

The results in the table 4 indicate that the posttest mean scores of the experimental groups (E1 and E2) were higher than those of the control groups (C1 and C2). This shows that TGTCLS had an effect of enhancing achievement in mathematics as compared to CTM. To establish whether the MAT mean scores were significantly different, ANOVA was done and the results are shown in table 5.

Sum of Squares	Df	Mean Square	F-ratio	p-value
1206.259	3	402.086	9.018	.000*
7624.621	171	44.588		
8830.880	174			
	Sum of Squares 1206.259 7624.621 8830.880	Sum of SquaresDf1206.25937624.6211718830.880174	Sum of SquaresDfMean Square1206.2593402.0867624.62117144.5888830.880174	Sum of Squares Df Mean Square F-ratio 1206.259 3 402.086 9.018 7624.621 171 44.588 8830.880 174 44.588

Table 5. ANOVA of the MAT Posttest mean scores by Learning Approach

* Significant at 0.05 level

The results in Table 5 reveal that the difference in MAT post-test means among the groups was statistically significant, F (3, 171) = 9.018, P< 0.05. In order to reveal where the differences were, Scheffe's post Hoc test of multiple comparisons was done. Scheffe's method was preferred since the group sizes were unequal; moreover, comparisons other than simple pair-wise between two means were not of interest (Kleinbaum & Kupper, 1998). The results of the Scheffe's tests are shown in Table 6.

Learning Method	Learning Method	Mean Difference	SE	P-Value
Ι	J	(I-J)		
E1	C1	4.07*	1.33	0.027
	E2	-1.67	1.44	0.733
	C2	4.79*	1.52	0.022
C1	E1	-4.07*	1.33	0.027
	E2	-5.71*	1.38	0.001
	C2	0.72	1.47	0.971
E2	E1	1.67	1.44	0.733
	C1	5.71*	1.38	0.001
	C2	6.43*	1.57	0.001
C1	E1	-4.79*	1.52	0.022
	C1	-0.72	1.47	0.971
	E2	-6.43*	1.57	0.001

Table 6. Multiple comparison of MAT Posttest Mean scores by Learning Approach

* Significant at 0.05 level

The results in Table 6 indicate that the difference in MAT mean scores of groups E1 and C1, E1 and C2, E2 and C1 and E2 and C2 were statistically significant at p < 0.05. However there was no statistically significant difference in the means between groups E1 and E2 (p > .05) and groups C1 and C2 (p > .05). Scheffe's multiple comparison tests also revealed that there was a statistically significant difference in favour of the experimental groups. The results show that TGTCLS enhanced positive effect on mathematics achievement. The null hypothesis that stated there is no statistically significant difference in mathematics achievement between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods was therefore rejected.

MAT Mean Gain Analysis

The gains of E1 and C1 were determined by obtaining difference between the pre-test and post-test mean scores and used to explain improvements in learning outcomes. Results of the mean gain analysis are shown in Table 7

Stage	Group	
Stage	E1 (N = 45)	C1 (N = 53)
Pre-test mean	1.93	1.78
Post-test mean	18.91	14.84
Gain	16.98	13.06

Table 7. S	Students'	MAT	Mean	Gains
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Results in Table 7 indicate that the experimental group E1 had mean gain of 16.98. The control group CI had a mean gain of 13.06 thus the level of achievement in the group which was exposed to TGTCLS was better than that of the group C1 which was taught using the CTM.

DISCUSSION

The results of the Analysis of Variance of the MAT scores show that differences between the control and experimental groups were statistically significant in favor of the experimental groups. On the basis of these results, the hypothesis suggesting that there was no statistically significant difference in mathematics achievement between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods was rejected. The experimental group E1 had a 16.98 increase from pretest to posttest. The control group had a 13.06 increase from pretest to posttest. There was a 4.92 difference between the increases of the experimental over the control group. The findings reveal that there was a significant difference in mathematics achievement between the students taught using TGT Cooperative Learning Strategy and those taught using lecture teaching method. These results agree with the results of a study conducted by Salam, Hosain & Rahman (2015) on the effects of using Teams-Games- Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Bangladesh. The experimental group had a higher increase from pretest to posttest than the control group had undergone the same traditional lecture method as before. The results of this investigation revealed that there were significant differences in the achievement scores of students who were exposed to TGT as a cooperative learning teaching technique compared to the lecture teaching method.

In this study, students who were members of experimental groups performed better on the individually completed test than members of the control groups. These findings further confirm the results of a study conducted by Ke and Grabowski (2007) in United States of America on the effects of cooperative Teams-Games-Tournaments on mathematics performance and attitudes. The study indicated that game playing was more effective than drills in promoting mathematics performance, and cooperative game playing was most effective in promoting positive attitude towards mathematics regardless of students' individual differences.

CONCLUSION

TGTCLS had a significant effect on mathematics achievement among secondary school students. Students who were taught using TGTCLS performed better than those who were taught using conventional teaching methods. This implies that it facilitates learning of mathematics better than the conventional teaching methods.

IMPLICATIONS OF THE FINDINGS

TGTCLS resulted to higher mathematics achievement and this shows that if TGTCLS is used in teaching mathematics, the performance of students would improve. Since majority of secondary school students are in sub-county schools, Teams-Games-Tournaments Cooperative Learning strategy should be incorporated into the teaching of mathematics at the secondary school level in order to alleviate the dismal performance in mathematics.

RECOMMENDATION

It is recommended that secondary school teachers and students be encouraged to apply Teams-Games-Tournaments Cooperative Learning Strategy during the teaching and learning of mathematics in order to improve students' mathematics achievement. Curriculum developers and implementers are likely to benefit from this study in deciding on the appropriate learning strategy in order to improve mathematics performance. It is further recommended that teacher training colleges and universities should emphasize on Teams-Games-Tournaments Cooperative Learning Strategy as an effective method of teaching in the course of training of mathematics teachers.

Further research should be undertaken in the following areas which were not part of the scope of the current study:

- (i) A study should be conducted on the students' attitudes towards teaching using Teams-Games-Tournaments Cooperative Learning Strategy versus when taught using conventional teaching methods.
- (ii) Research on secondary school mathematics topics that can be effectively taught using Teams-Games-Tournaments Cooperative Learning Strategy should be carried out.

REFERENCES

- [1]. Aburime, F. E. (2009). Harnessing Geometric Manipulative as a Revitalization Strategy for Mathematics Education in Nigeria Sutra: *International Journal of Mathematical Science Education 2* (1), 22-28, 2009.
- [2]. Amoo, S. A. (2001). *Curriculum Ideals and Realities for Sustainable Educational Development*. A paper presented at the 14th Annual Conference of the Curriculum Organization of Nigeria, Abuja, Nigeria, September 18-21.
- [3]. Anderson, L. W. & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching and Assessing*. Abridged Edition, Boston, MA: Allyn and Bacon.
- [4]. Awofala, A. O. A., Fatade, A. O. & Ola- Oluwa, S. A. (2012). Achievement in Cooperative versus Individualistic Goal-Structured Junior Secondary School Mathematics Classrooms in Nigeria. *International Journal of Mathematics Trends* and Technology, Vol. 3.
- [5]. Clements, D. H & Battista, M. T. (2012). *Constructivist Learning and Teaching*. Cambridge, Massachusetts. TERC.
- [6]. Dambatta, B.U. (2013). Transforming Nigeria for Vision 20:2020: Implication for Mathematics and Mathematics Education. Abacus. *Journal of Mathematics Association of Nigeria 38*(1), 137-145.
- [7]. David & Roger J. (2001). "An Overview of Cooperative Learning." Retrived from: http://www.clcrc.com/pages/overviewpaper.html 2nd December 2010.
- [8]. DeVries, D. L., & Edwards, K. J. (1972). *Student teams and instructional games: Their effects on cross-race and cross-sex interaction*. (Report 137) Center for Social Organization of Schools, Baltimore: Johns Hopkins University Press.
- [9]. Doolittle, P. E. (1995). Understanding Cooperative Learning through Vygosky's Zone of Proximal Development. Paper presented at the Lilly National Conference on Excellence in College Teaching. Columbia, SC. Southeastern Louisiana University.
- [10]. Effandi, Z. (2005). *Asas Pembelajaran Koperatif Dalam Matematik*. Shah Alam: Karisma Publications Sdn Bhd.
- [11]. Effandi, Z. & Zanaton, I. (2007). Promoting Cooperative Learning in Science and Mathematics: A Malaysian Perspective. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(1), 35-39
- [12]. Gall, M. D., Gall, J. P. & Borg, W. R. (2007). *Education Research: An Introduction* (8thed.) Boston: Allyn and Bacon.
- [13]. Githua, B. N. & Mwangi, S.W. (2013). Effects of Using Loci-Kit Models on Secondary Schools Students' Achievement in the Mathematics Topic "Loci" in Kibwezi District, Kenya. Asian Journal of Management Sciences and Education. Vol.2. No.2, 100-112
- [14]. Ke, F. & Grabowski, B. (2007). Game Playing for Maths Learning: cooperative or not? *British Journal of Educational Technology*, *38*(2), pp. 249-259.
- [15]. Kenya Institute of Education, (2002). *The Secondary School Syllabus*. vol.2. Nairobi: KIE.
- [16]. Kenya Literature Bureau (2003). Secondary Mathematics. Students Book Two.3rd Edition, Nairobi. Kenya Literature Bureau.

- [17]. Kleinbaum, D.J. & Kupper, L.L. (1998). Applied Regression Analysis and other Multivariate Methods. Massachusetts. Duxbury
- [18]. Koohang, A., Riley, L., Smith, T. & Schreurs, J. (2009). E-Learning and Constructivism: From Theory to Application. *Journal of E-learning and Learning Objects, Vol.5,* 93-95.
- [19]. KNEC (2012-2018). The Year 2011-2017 KCSE Examination Report. Nairobi: KNEC.
- [20]. Mji, A. & Makgato, M. (2006). Factors that Associate with High School Learners' Poor Performance. Spotlight on Mathematics and Physical Sciences, South Africa. *Journal of Education, vol.26* (2) 253-266.
- [21]. Mugenda, O. M. & Mugenda, A. G. (2003). *Research Methods; Quantitative and Qualitative Approaches*. Nairobi: African Center for Technology Studies (ACTS).
- [22]. Mutange, R. E. (2006). Effects of the Problem Solving Approach on students' Mathematics Achievement, Self-Concept and Perception of Classroom Environment in Vihiga District, Kenya. Egerton University: Unpublished Thesis.
- [23]. Nyeri Central Sub-County Office, (2016). *KCSE 2010, 2011, 2012, 2013, 2014 & 2015 Results Analysis*. Nyeri Central Sub-County.
- [24]. Nyeri SMASSE (2007). *Nyeri Baseline Study Report*. Unpublished report presented to Mathematics and Science Teachers in Nyeri District, Kenya during April 2008 Inservice of teachers.
- [25]. OECD (2016). *PISA 2015 Results in Focus:* Retrieved April 20th, 2017 https://www.oecd.org/pisa/pisa-2015-results in focus.
- [26]. Ogan, G. C. (2015). Mathematics as a Tool for Achieving the Vision 20:2020 Goal of National Transformation. *International Journal of Education, Learning and Development 3(*8), pp.57-61. Published by European Centre for Research Training and Development UK (www.eajournals.org)
- [27]. Piaget, J. (1972). *Psychology and Epistemology: Towards a Theory of Knowledge*. Harmondsworth: Penguin
- [28]. Salam, A, Hosain, A & Rahman, S (2015). Effects of using Teams Games Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Bangladesh. *Malaysian online journal of educational technology. Vol. 3.*
- [29]. Slavin, R. E. (2011). *Instruction based on cooperative learning*. New York, NY: Plenum.
- [30]. Sunday, Y., Akamu. M. A. & Fajemidagba, M. O. (2014). Effects of Target-Task Mode of Teaching on Students' Performance in Geometrical Construction. Abacus. *Journal of Mathematical Association of Nigeria, 39*(1), 33-42.