EFFECTS OF TEAMS - GAMES - TOURNAMENTS COOPERATIVE LEARNING STRATEGY ON STUDENTS' MATHEMATICS ACHIEVEMENT, SELF- CONCEPT AND PERCEPTION OF LEARNING ENVIRONMENT IN PUBLIC SECONDARY SCHOOLS IN NYERI CENTRAL SUB-COUNTY, KENYA

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DEDICATION

To my dad Alban, my wife Jedidah and sons: Newton, Morris and Eric.

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I wish to thank our Heavenly Father for His grace and mercy in the course of my study. I specially thank my two supervisors Prof. B. N. Githua and Prof. F. N. Keraro both from the Department of Curriculum, Instruction and Educational Management of Egerton University for their tireless assistance by offering guidance and insights at all the stages of my work. I thank the Ministry of Education, State Department of Basic Education for granting me the opportunity to carry out this study in Kenyan Secondary schools. I acknowledge the Principals, mathematics teachers and the Form Two students in the secondary schools that were involved in the study for their valuable support and cooperation during the study. I sincerely thank Dr. J. K. Ng'eno of Egerton University, Dr. R. K. Karanja, Mr. Peter Nderitu and Mr. John N. Kamau for their valuable assistance and support especially in the preparation of research tools. To my colleague classmates in the Master of Education (Science Education) class of 2011, thank you for encouraging each other.

ABSTRACT

Mathematics is an important component of everyday human activities and survival. Despite its significance, learners' performance in the subject has been dismal. Conventional teaching methods used in class have impacted negatively on learners' achievement, self-concept and perception of mathematics learning environment. This study sought to investigate the effects of Teams-Games-Tournaments Cooperative Learning Strategy (TGTCLS) on Students' Mathematics achievement, Self–Concept and Perception of the learning environment. A Quasi-experimental Solomon Four Non-Equivalent Control Group Design was used in the study. The target population was all secondary school students in Nyeri 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, a mathematics topic which is taught at Form Two level in secondary schools. Two experimental groups (E1 and E2) were taught using TGTCLS as treatment while two control groups (C1 and C2) were taught using the conventional teaching methods (CTM). Data was collected using a Mathematics Achievement Test (MAT), a Mathematics Self-Concept Questionnaire (MSCQ) and a Mathematics Learning Environment Perception Questionnaire (MLEQ). The instruments were validated by four experts in Educational Research in the Department of Curriculum, Instruction and Education Management of Egerton University and three secondary school Mathematics teachers. The instruments were pilot-tested in one of the Sub-County schools in the neighboring Tetu Sub-County. Cronbach Alpha Coefficient was used to estimate the Reliability of the instruments. Reliability Coefficient of 0.850, 0.782 and 0.861 were attained for MAT, MSCQ and MLEQ respectively and hence the instruments were deemed to be reliable. Descriptive (mean and standard deviation) and inferential statistics (t-Tests and ANOVA) were used to analyse the data with the aid of Statistical Package for Social Sciences version 20. Findings of this study show that learners in the experimental groups had better scores in MAT, MSCQ and MLEQ than those in the control groups. Secondary school mathematics teachers and students are encouraged to apply TGTCLS in order to improve achievement, students' self-concept and perception of classroom learning environment. Teacher trainers, curriculum developers and implementers are likely to benefit from this study in deciding on the appropriate learning strategy for learners in order to improve mathematics performance in the country.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CTM	Conventional Teaching Methods
GOK	Government of Kenya
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KIE	Kenya Institute of Education
KNEC	Kenya National Examinations Council
MAT	Mathematics Achievement Test
MLEQ	Mathematics Learning Environment Perception Questionnaire
MSCQ	Mathematics Self-Concept Questionnaire
NACOSTI	National Commission for Science, Technology and Innovation
OECD	Organization for Economic Cooperation and Development
PISA	Programme for International Students Assessment
SMASSE	Strengthening of Mathematics and Science at Secondary Education
SPSS	Statistical Package for Social Sciences
STAD	Students Teams-Achievement Divisions
TAI	Teams-Assisted Individualization
TGT	Teams-Games-Tournaments
TGTCLS	Teams-Games -Tournaments Cooperative Learning Strategy

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Mathematics is an important component of human activities and survival. Its importance to human existence cannot be overemphasized in view of its application to human everyday life activities (Sunday, Akamu & Fajemidagba, 2014). Mathematics is an essential discipline that is recognized as a tool for solving everyday problem faced by individuals. Mathematics as such is an important subject as knowledge of it enhances a person's reasoning, problem-solving skills, and in general, the ability to think (Ogan, 2015).

Mathematics helps individuals make sense of their world inside and outside the school in that basic numeracy skills acquired in early years in school have a great impact on many facets of life such as computer applications. Mathematics provides the underpinning language for the rest of science and technology. It also empowers individuals for the conduct of private and social life (Conway & Sloane, 2005).

According to Dambatta (2013), knowledge of mathematics allows scientists to communicate ideas using universally accepted technology since it is truly the language of sciences. The results of mathematical research benefit the economy in the fiber-optic network carrying telephone conversations, computers that carryout various functions, weather forecasting and predictions, the design of fuel efficient automobiles and airplanes, traffic control and medical imaging.

Mathematics empowers individuals with broad knowledge and transferable skills thus regarded as essential to a liberal education in that it promotes integration of learning across the curriculum and co-curriculum, and between academic and experiential learning in order to develop specific learning outcomes necessary for work and life (Woodhouse, 2012). Therefore, good mathematics education is important for its usefulness in careers such as environmental studies, engineering, business, medicine and psychology. Knowledge of mathematics helps students to understand calculators and computers (Grolier Encyclopedia of Knowledge, 2002). If Kenya is to achieve her Vision 2030, whose aim is to make Kenya an industrialized middle income country by the year 2030 (Government of Kenya [GOK], 2007), then there is need to promote Science and Technological development through mathematics education.

Objectives of teaching mathematics at secondary school level in Kenya are well stipulated in the secondary school mathematics syllabus. By the end of the secondary school course the learner is expected to be numerate, orderly, logical, accurate and precise in thought. He/she should be competent in appraising and utilizing the mathematical skills in playing a positive role in the development of a modern society. It is also expected that a learner will make precise and logical use of mathematical knowledge and skills to concretize problems from everyday situations, comprehend, analyze, synthesize and evaluate a set of numerical data to both familiar and unfamiliar situations (KIE, 2002).

According to Organization for Economic Cooperation and Development (OECD, 2016), 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 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 which implies 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.

Mathematics is one of the school subjects in which many students perform poorly in both national and public schools in Nigerian Secondary Schools. Mundia (2010), Aburime (2009), Adeniji (1998) and Amoo (2001) 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. This resulted in a few students taking mathematics and those who did so performed poorly.

In Kenya students' performance in Mathematics at the Kenya Certificate of Secondary Education (KCSE) examination from 2008 to 2017 revealed that the students' performance nationally was consistently low as shown in Table 1.

Table 1

KCSE Mathematics Percentage Mean Scores (2008-2017)

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Paper 1	22.76	22.37	26.21	21.36	29.46	28.12	24.54	25.53	23.74	24.49
Paper 2	19.82	19.89	19.92	28.22	27.86	27.03	23.50	28.23	17.84	26.47
Grand Mean	21.29	21.13	23.07	24.79	28.66	27.58	24.02	26.88	20.78	25.48

Source: KNEC (KCSE 2008-2017) Reports

Paper 1 consists of items from mainly Forms One and Two work while Paper 2 mainly tests Forms Three and Four work as stipulated in the Secondary School Syllabus (KIE, 2002). The grand mean is the average of paper 1 and 2. The results indicated that there was an improvement in the percentage grand mean score from 21.29% in 2008 to 28.66% in 2012 and a drop in performance in the subsequent years. With the increase in the candidature from 444,774 in 2013 to 609,525 in 2017, the grand mean dropped from 27.58 to 25.48. Between 2008 and 2017, results of papers 1 and 2 were generally poor hence there was need for intervention so as to improve the performance.

The persistent poor performance in mathematics as compared to other subjects is also registered in Nyeri Central Sub-County as shown in Table 2. The students' mathematics 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. Performance in mathematics was fluctuating between 2011 and 2017. The results indicate that there was a drop in the performance of mathematics from performance index of 4.951 in 2011 to 2.867 in 2016. There was a slight improvement to a mean score of 3.258 in 2017. Despite the improvement, the performance index in mathematics was low as compared to the overall performance index for all the subjects combined which was 4.379 in 2017. Learners' poor performance in Mathematics affects the overall performance of students hence there is need for intervention to improve the performance of the subject.

Table 2

Students' Mathematics Performance Indices compared with Other Subjects at KCSE (2011-2017) in Nyeri Central Sub-County

SUBJECT	2011	2012	2013	2014	2015	2016	2017
English	6.720	7.068	8.528	7.024	6.551	2.490	2.643
Kiswahili	6.340	5.599	5.696	6.083	6.217	4.180	3.673
Mathematics	**4.951**	**5.597**	**4.870**	**4.960**	**4.950**	**2.867**	**3.258**
Biology	5.815	5.766	5.243	5.643	5.585	3.088	2.227
Physics	6.621	6.584	4.693	6.372	6.991	4.113	3.584
Chemistry	5.318	5.529	4.042	5.093	6.475	2.724	2.661
History	5.996	6.365	5.412	6.305	6.840	5.755	4.915
Geography	6.133	6.668	4.619	5.779	5.763	5.345	5.093
CRE	6.762	6.460	6.264	6.896	7.138	5.521	4.095
H/Science	5.712	6.717	5.441	7.366	7.000	6.670	6.613
Art& Design	5.633	6.645	6.500	7.469	7.417	9.900	8.160
Agriculture	5.834	5.788	5.481	5.703	6.567	3.758	2.902
Computer	9.120	9.468	8.256	9.325	8.667	6.667	8.250
Music	9.118	7.385	10.21	8.375	8.077	5.360	9.375
B/Studies	6.687	6.718	6.310	6.641	6.789	3.976	3.286

Source: Nyeri Central Sub-County Education Office (2018)

Kanja, Iwasaka, Baba and Ueda (2001) carried out a baseline study on Strengthening Mathematics and Sciences at Secondary Education (SMASSE) in Kenyan secondary schools and found that students performed poorly in the basic concepts in mathematics. This was attributed to the quality of teaching and learning environment. Students appeared to lose interest in the learning of mathematics as they progressed through the school system since they had not understood the basic mathematics needed to function effectively in the society. As a result, performance of students in mathematics at the end of the secondary school education was poor compared to other subjects.

Constructivist learning is one of the recent developments in learning mathematics and science which involves a teacher as a facilitator while students are active researchers and discoverers of knowledge. Constructivist learning 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. It involves knowledge construction with exploration in order to encourage students to seek knowledge independently rather than reproduction. Teachers serve as guides, monitors, coaches, tutors and facilitators (Koohang, Riley, Smith & Schreurs, 2009). Taber (2006) analyzed the core ideas on constructivist learning. First, knowledge is actively constructed by a learner, not passively received from the outside and hence learning is not imposed on a learner. Secondly, learners come to the learning situation especially in science and mathematics with existing ideas which may be more deeply rooted and well developed about many phenomena. Thirdly, learners have their own individual ideas about the world and, therefore, teaching has to take into account a learner's existing ideas much deeper.

According to Clements and Batista (2012), mathematical ideas and truths, both in use and in meaning, are cooperatively established by members of a culture. Thus, the constructivist classroom is seen as a culture in which students are involved not only in discovery and invention but 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). The Education Alliance (2006) looked at a variety of research studies, and identified use cooperative learning strategies as one of the best practices in mathematics education which may lead to improved performance in mathematics. Effandi (2005) investigated the effect of cooperative learning on student achievement and problem solving skills. The study found that cooperative group instruction showed significantly better results in mathematics achievement and problem solving and hence concluded that cooperative learning methods are a preferable alternative to traditional instructional methods.

According to Slavin (1995), there are several cooperative learning strategies. One of them is the Jigsaw where students are responsible for teaching each other the material. Assignment is divided into several expert areas and each student is assigned one area. Experts from different groups meet together, discuss their expert areas, return to their groups and take turns teaching. Another cooperative learning strategy is Student Teams-Achievement Divisions (STAD) where students are grouped according to mixed ability, sex and ethnicity. A teacher presents materials then students work within their groups and finally students take individual quizzes. Students earn points based on how well they scored on the quiz compared to past performance.

According to Effandi and Zanaton (2007), Teams-Games-Tournaments (TGT) is a cooperative learning strategy where students compete 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 do at their tournament tables. Teams-Games-Tournaments Cooperative Learning Strategy has three basic elements: teams in which students are assigned to equal teams categorized by equivalent academic levels, games where skill exercises relating to content material are played during weekly tournaments and tournament in which students represent their teams and compete individually against students from other teams.

Studies have been conducted on the effects of TGT Cooperative Learning Strategy on learners' achievement. Chambers and Abrami (1991) conducted a study in Montreal, Canada on the effects of the TGT technique on students' individual outcomes, team outcomes and academic achievement perceptions of students**.** This field investigation found that students who were members of successful teams performed better on the individually completed test and rated their ability and luck higher than did members of unsuccessful teams.

Ke and Grabowski (2007) conducted a study in the United States America on the effects of cooperative Teams-Games-Tournaments (TGT) 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 for promoting positive attitude towards mathematics regardless of students' individual differences. A baseline survey was carried out by Nyeri County SMASSE trainers in Nyeri County in 2007. One of the objectives of the study was to find out the topics which were challenging to students in science and mathematics. Results of the study are shown in Table 3.

Table 3

Challenging Topics in Secondary School Mathematics indicated by Baseline Survey Conducted by Nyeri County SMASSE Trainers

Class	**Form One**	**Form Two**	**Form Three**	**Form Four**
Topics in decreasing order of difficulty	(i)Scale drawing (ii)Integers	(i) Linear motion (ii)Similarity& Enlargement (iii)Indices& Logarithms	(i) Vectors (ii)Surds& logarithms (iii)Errors& Approximations (iv) Compound proportion	(i) Linear Inequality (ii) Locus (iii) Transformations

Source: Nyeri County SMASSE Baseline Survey (2007)

The topic "Similarity and Enlargement" was rated as the second most challenging topic in the form two mathematics syllabus. The topic is one of the difficult topics to learners perhaps due to misconception of the terms 'similarity' and 'enlargement'.

The topic "Similarity and Enlargement" was poorly performed at the Kenya Certificate of Secondary Education (KCSE) examination. For instance, in the 2014 KCSE Paper 1, most candidates were unable to determine the scale factor of enlargement and hence teachers were advised to emphasize on the concept of enlargement and give more exercises. In 2015 KCSE Paper 1, Question 23, most candidates were unable to find the slant height using the concept of similarity which showed poor mastery of content. Teachers were advised to teach the area thoroughly and give more practice in the topic for the concepts to be understood clearly (KNEC reports 2012, 2013, 2014, 2015 & 2016). The reports indicated that most candidates were unable to solve problems involving the topic 'Similarity and Enlargement'. This is likely to have contributed to the poor performance in Paper one hence overall dismal performance in mathematics as a subject over the years. There is therefore need to seek effective strategies of instruction so that learners understand the topic and mathematics in general.

According to Weiten, Dunn and Hammer (2012), self-concept is a collection of beliefs about one's own nature, unique qualities, and typical behaviour. It is a collection of self-perception. Self-concept is the totality of an individual's beliefs, preferences, opinions and attitudes organized in a systematic manner, towards our personal existence (Sincero, 2012). Mathematics Self-Concept refers to student self-evaluation of self-perceived personal mathematical skills, abilities, enjoyment and interest in mathematics (Marsh, 1996). Students who have low levels of mathematics self- concept perform worse in mathematics compared to those who are more confident in their own abilities as mathematics learners (OECD, 2013).

Mathematics Classroom Learning Environment refers to dynamic mathematics classroom ecological system which is an outgrowth of both teacher and learner interactions under certain instructional, organizational factors as well as classroom physical aspects (Hamachek, 1995). According to Kilpatrick, Swafford and Findell (2001), mathematics learning environment can instil habitual inclination to see mathematics as sensible, useful and worthwhile by solving problems, reasoning, developing understanding, practicing skills and building connections between learners' previous knowledge and new knowledge.

Clements and Sarama (2009) posit that mathematics learning environment should reflect the beauty and creativity that is at the heart of mathematics. According to Shellard and Moyer (2002), there are three critical components to effective mathematics instruction. They include teaching for conceptual understanding, developing children's procedural literacy and promoting strategic competence through meaningful problem-solving investigations.

According to Effandi and Zanaton (2007), the purpose of the Teams-Games-Tournaments (TGT) strategy is to create an effective classroom environment in which students are actively involved in the learning process and are consistently receiving encouragement. Students' perception of mathematics classroom environment affects their achievement. Rajoo (2013). posit that by knowing students' perceptions, a teacher can formulate the best strategies to provide ideal mathematics classroom environment and ensure better performance in mathematics.

1.2 Statement of the Problem

While Teams-Games-Tournaments cooperative learning as an instructional methodology is an option for teachers, it is currently the least frequently used. Conventional teaching methods used by most teachers are mainly expository in nature and have been blamed for the learners' inability to achieve meaningful learning in mathematics. Most of the instruction in schools involves the use of formal lectures, demonstration, supervised practice, dill and practice, seatwork or competition in which students are isolated from one another and sometimes forbidden to interact. Most classroom time is spent in teacher talking, with very little of the students' classroom time used for reasoning about or expressing an opinion. Despite mathematics being a compulsory subject for all the students at Secondary School level in Kenya, students' mathematics performance has been dismal. The current teaching strategies that are implemented by Mathematics teachers at the high school level have resulted to poor performance in mathematics, low students' mathematics self-concept and negative influence on students' perception of classroom learning environment. It is of outmost importance that teachers at our institutions be empowered and exposed to effective teaching strategies in order to alleviate this problem. There is inadequate documented information on Teams-Games-Tournaments Cooperative Learning Strategy and its effects on students' mathematics achievement, self-concept and perception of mathematics classroom learning environment in Kenya and in particular Nyeri Central Sub-County Secondary Schools. This study therefore intended to fill the gap.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of using TGT Cooperative Learning Strategy on students' mathematics achievement. The study was to also examine the effects of using TGT Cooperative Learning Strategy on students' mathematics self-concept and perception of mathematics classroom learning environment in secondary schools.

1.4 Objectives of the Study

This study was guided by the following specific objectives:

(i) To determine whether there is any difference in mathematics achievement between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

(ii) To determine whether there is any difference in mathematics self-concept between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

(iii) To determine whether there is any difference in students' perception of mathematics classroom learning environment between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

1.5 Hypotheses of the Study

The following null hypotheses were tested at Alpha (α) =0.05 level of significance.

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.

Ho2: There is no statistically significant difference in mathematics self-concept between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

Ho3: There is no statistically significant difference in students' perception of the mathematics classroom learning environment between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

1.6 Significance of the Study

The findings of this study may be beneficial to secondary school teachers in applying the best methods and strategies which arouse learners' interest and with high learners' participation. The outcomes of the study may be helpful to the secondary school students to identify the learning strategy that enhances mathematics achievement, self-concept and perception of mathematics learning environment. Information obtained from the findings will be helpful to teacher educators in teacher training colleges and universities in Kenya about effective teaching strategies in the preparation of effective teachers which will enhance improved performance in Mathematics. The findings will also be beneficial to education officers and policy makers in deciding appropriate learning strategies for learners to improve their performance.

1.7 Scope of the Study

All Form Two students in Nyeri Central Sub-County were eligible respondents. The study involved Form Two students in the 4 sampled four Sub-County public secondary schools in the Sub-County. The mathematical content covered during the study included all the sub-topics outlined under the topic 'Similarity and Enlargement' in the mathematics syllabus (KIE, 2002). The treatment took four weeks. The study also investigated whether there would be a change in students' mathematics self-concept and the perception of classroom learning environment as a result of using Teams-Games-Tournaments Cooperative Learning Strategy.

1.8 Limitations of the Study

The study was limited to the subject matter of one topic 'Similarity and Enlargement' which is taught at Form Two level. Individual differences of students in any mathematics classroom may contribute to behavioural phenomena observed in a given setting. In this study, the researcher had to involve students in Sub-County schools since they have similar characteristics and the school environment is more or less similar. Therefore, data obtained from this study may not be valid for other groups and settings.

1.9 Assumptions of the Study

In this study, the following assumptions were made:

(i) Teachers and respondents involved in the study would cooperate in collecting and recording the relevant data.

(ii) All the respondents in the study were honest in providing the needed information.

1.10 Definition of Operational Terms

The following operational definitions were used in this study:

Conventional Teaching Methods - These are the teaching/learning methods that teachers frequently use and have been used for a long time (Dictionary, Encyclopedia & Thesaurus, 2012). In this study they are teacher-centered traditional modes of instruction commonly used in mathematics classroom e.g formal lecture, demonstration, supervised practice, dill and practice.

Cooperative Learning: Cooperative learning is the instructional method in which teachers organize students into small groups and they then work together to help one another learn academic content. Students work together on a structured activity, are accountable for their work and the work of the group as a whole is also assessed (Slavin, 2011).

Mathematics Achievement –It is a measure of the degree of success in performing tasks in mathematics after teaching or instruction (Dictionary, Encyclopedia & Thesaurus, 2012). In this study achievement was indicated by the scores attained after administering the Mathematics Achievement Test.

Mathematics Self-Concept – Self-concept refers to the set of cognition and feelings that one has on oneself, self- identity, self-image and ideal self (Majda & Branka, 2010). In this study Mathematics Self-Concept refer to student attitude, feelings and knowledge about own abilities, skills, appearance and social acceptability. It was measured on a five point Likert scale.

Mathematics Classroom Learning Environment– It refers to dynamic mathematics classroom ecological system which is an outgrowth of both teacher and learner interactions under certain instructional, organizational factors as well as classroom physical aspects (Hamachek, 1995). According to Protheroe (2007), an effective mathematics classroom is one that students are actively engaged in doing mathematics not watching others do the mathematics for them or in front of them solving challenging problems. In this study, it included teacher and students activities, time spent, language and instructional materials in use during mathematics lessons.

Perception of Classroom Learning Environment– Perception is a personal view about a phenomenon. It refers to the ability to understand the true nature of something. Classroom learning environment is one which the teaching-learning process varies according to such factors as the role of the teacher, the role of the learner, the teaching method and the nature of instructional activities (Kiboss, 1997). In this study it meant how learners perceive the mathematics classroom learning environment and was measured on a five point Likert scale.

Teams-Games-Tournaments (TGT) –This is a cooperative learning method in which students compete with members of other teams to contribute points to their team score. Students compete in at least three persons "tournament tables" against others with a similar past record in mathematics. After then a procedure changes table assignments to keep the competition fair. The winner at each tournament table brings the same number of points to his or her team which means that low achievers and high achievers have an equal opportunity for success. High performing teams earn team rewards (DeVries & Edwards, 1972).

Teams-Games-Tournaments Cooperative Learning Strategy - In this strategy, students are assigned to teams of equal number of students of mixed academic levels. There are games which include skill exercises relating to content material (Effandi & Zanaton, 2007). In this study teams of five students were constituted, games were played during fortnight tournaments in which students represented their teams and competed individually against students from other teams. The winnings were brought back to their teams. Total winnings were tallied across teams and team champions were announced and rewarded.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature relevant to the variables of interest in this study. First it focuses on students' achievement in Mathematics. Instructional Methods used in Teaching Mathematics in Secondary Schools have been explained. Cooperative learning strategies are then discussed including Teams-Games-Tournaments Cooperative Learning Strategy. Mathematics students' self-concept and mathematics classroom learning environment have been outlined. Theoretical and conceptual frameworks of the study conclude this chapter.

2.2 Students' Achievement in Mathematics

Despite the important role mathematics play in society, performance in the subject has been persistently poor globally. According to Organization for Economic Cooperation and Development (OECD, 2016), 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 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 which implies 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.

In Kenya, students' performance in mathematics in KCSE from 2008 to 2017 revealed that the students' performance nationally was consistently low despite the subject being compulsory to all students at secondary school level (KNEC, 2009-2018). Students' performance was dismal as portrayed in Table 1. The KCSE (2008-2017) mathematics results can be represented graphically as in Figure 1.

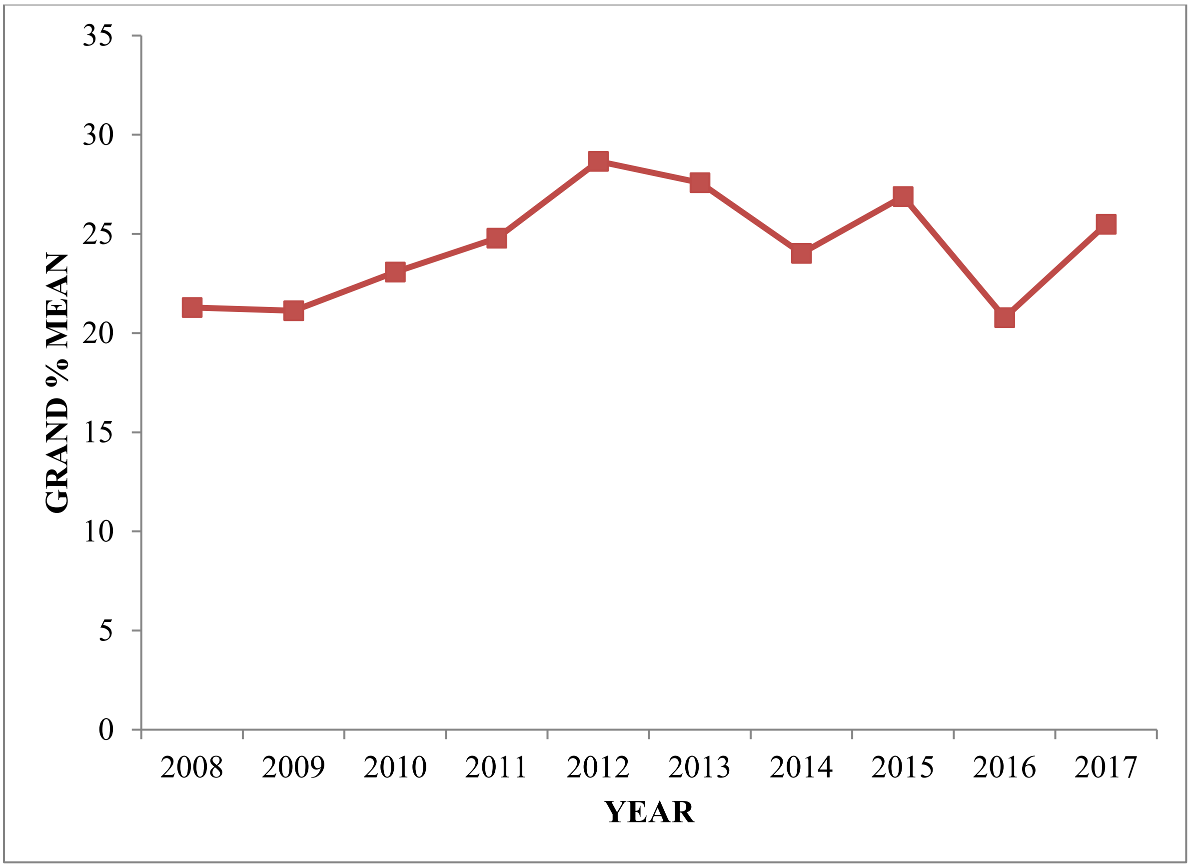


Figure 1. Candidates Grand Percentage Mean Score in KCSE (2008-2017)

Figure 1 shows that there was an increasing trend in the percentage mean score from the year 2009 to 2012. There was a downward trend from the year 2012 to 2014 and a slight improvement in the year 2015. The worst performance was in the year 2016 with a grand percentage mean of 20.78 which was as a result of stringent measures that were taken by KNEC in a bid to curb examinations irregularities hat had been rampant in the past years. Generally, the performance in mathematics was dismal and inconsistent which led to this study in an attempt to alleviate the problem.

Changeiywo (2001) points out that time allocation, availability of instructional materials, lack of well trained teachers, inadequate relevant materials that meet the curriculum needs of the society, attitude of teachers towards the subject, examination pressure and language of instruction used in the subject are factors that affect the students' performance in sciences and mathematics. Instructional methods can also affect the performance of students in science and mathematics.

According to Mbugua, Kibet, Muthaa and Nkonke (2012), the school based factors that contribute to poor performance include: ineffective methods of teaching, inadequate teaching/learning materials, ineffectiveness of mathematics teachers in teaching, teachers' attitude towards mathematics, heavy teachers' workload and inadequate coverage of the syllabus. In a bid to overcome the problems associated with the low learners' achievement in mathematics, there is need to explore better methods of teaching mathematics.

2.3 Instructional Methods used in Teaching Mathematics in Secondary Schools

2.3.1 Conventional Teaching Methods

According to Kiruhi, Githua and Mboroki, (2009), conventional teaching methods are the ordinary teaching methods used by teachers to deliver the contents of the syllabus to the learners. These methods are highly dependent on the skills of the teacher in that the teacher maintains control of the subject matter to be learnt in the classroom while the learners are most of the times passive recipients of information. They are mainly direct instruction methods which include formal lecture, demonstration, drill and practice, didactic questioning and discussions.

Formal lecture is a didactic method of teaching in which a teacher communicates to passive learners who listen and take notes. This method motivates students to learn if the teacher is enthusiastic and humorous; it is cost effective in terms of teacher/student ratio. The method allows extensive coverage of content in a short time and requires limited resources. It can be useful for conveying information to large classes and summarize main points of a lesson. This method is disadvantageous to the learners since it is highly dependent on the skills of the teacher and does not enhance interpersonal and communication skills. It is not suitable for developing higher level cognitive, affective and psychomotor objectives (Kiruhi, Githua & Mboroki, 2009).

Demonstration is an expository teaching method in which a teacher may show a procedure of solving mathematical problems. Students have to practice the skill for effective learning. Teachers use this method in class to save time. It is teacher-dominated since the teacher has to plan appropriately, must have knowledge of subject matter and follow a systematic procedure. It is not effective in most of the secondary schools because the classes are large. A teacher using this method may be tempted to lecture rather than demonstrate and hence the method may not be effective (Daluba, 2013).

Drill and Practice is a common method which is employed by mathematics teachers in secondary schools working with students who lack basic skills and knowledge of subject matter. Students are given questions to practice in order to learn basic skills or tasks. One of the disadvantages of this method is that it can turn out into busywork especially if the tasks are too easy or too difficult for majority of learners. This method is time consuming and time may not be available for learners to practice (Ornstein, 1995).

Questioning is the method in which a teacher asks questions while learners respond to the questions. This method arouses learners' interest and captures their attention. Teacher poses a question to learners, pauses to give adequate wait time before naming a learner to respond. If this method is to be effective, a teacher should avoid questions which encourage chorus answers, questions should be simple, non-ambiguous language distributed to the whole class and to the learners' ability (Kiruhi, Githua & Mboroki 2009).

Discussion/Learning Groups is a method which involves talking and may be teacher-to- learner or learner-to-learner while a teacher chairs the discussion. For a successful classroom discussion, a teacher has to carefully choose a task for discussion, prepare a worksheet to guide learners and provide learning materials. Students participate in a lesson; there is immediate feedback, high achievement of high level cognitive and non-cognitive objectives. This method may be time consuming and materials may not be available for use during discussion (Kiruhi, Githua & Mboroki, 2009).

Despite the wide use of various conventional methods in the teaching and learning of mathematics, performance has been dismal over the years. In an attempt to improve the learning of mathematics, researches on effects of non-conventional teaching methods are being carried are out.

2.3.2 Other Suitable Teaching Methods

These are mainly facilitation methods in which the focus is on a learner and a teacher as a guide facilitates and supports the schemes used by a learner in seeking new knowledge. These are constructivist approaches such as mastery, cooperative, creativity, experiential learning, problem-based learning, inquiry-based learning and independent study where learners are actively involved in the construction of knowledge under the guidance of the teacher (Kiruhi, Githua & Mboroki, 2009).

Constructivist learning 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. It involves knowledge construction with exploration in order to encourage students to seek knowledge independently rather than reproduction. Teachers serve in the role of guides, monitors, coaches, tutors and facilitators. Goals and objectives are derived by a student or in negotiation with a teacher or system. Students construct their own knowledge by testing ideas and approaches based on their prior knowledge and experience, applying these to a new situation and integrating the new knowledge gained with pre-existing intellectual constructs (Koohang, Riley, Smith & Schreurs, 2009).

2.4 Cooperative Learning

According to Slavin (2011), cooperative learning is an instructional method in which teachers organize students into small groups, and they then work together to help one another learn academic content. In cooperative learning, students work together in small groups on a structured activity. They are individually accountable for their work, and the work of the group as a whole is also assessed. Cooperative groups work face-to-face and learn to work as a team.

McCracken (2005) refers to cooperative learning as a teaching strategy where small groups of teams work together towards a common goal. In a cooperative learning classroom, the learning environment is structured in a way to ensure students work together and are able to see diverse viewpoints or ideas. Group work is not complete until everyone has mastered the concept. By starting students out with small amount of times and building to longer periods of time to work as a group will help students feel more confident working with others. Communication is the key and students will learn equal opportunity, to share ideas, give and receive feedback, how no one person takes over and information being original ideas of the group.

According to David and Roger (2001), cooperative learning is an approach of organizing classroom activities into academic and social learning experiences. Students must work in groups to complete the two sets of tasks collectively. Everyone succeeds when the group succeeds. An empirical study conducted by Whicker, Bol, and Nunnery (1997) revealed the necessity of cooperative learning for fostering mathematics education. This learning pedagogy had been widely practiced around the whole world especially in developed countries. Studies have found positive effects on mathematics achievement of elementary and middle school students in one Israeli mathematics program that used cooperative learning strategies (as cited in Slavin, 2011).Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks (Effandi & Zanaton, 2007).

2.4.1 Types of Cooperative Learning Groups

According to Johnson, Johnson and Smith (2006), there are three commonly recognized types of cooperative learning groups. These include informal, formal and cooperative base learning groups. Informal learning groups are ad-hoc groups which may be organized as an aid in direct teaching. These informal groups are particularly useful in breaking up the lecture into shorter segments interspersed with group activity. While this method leads to less time for lecture, it will increase the amount of material retained by students as well as their comfort working with each other. Formal learning Groups form the basis for most routine uses of cooperative learning. Groups are assembled for at least one class period and may stay together for several weeks working on extended projects. These are where students learn and become comfortable applying the different techniques of working together cooperatively.

Cooperative Base Groups are groups that are long-term, stable groups that last for at least a year and are made up of individuals with different aptitudes and perspectives. They provide a context in which students can support each other in academics as well as other aspect of their lives. The group members make sure that everyone is completing their work and hold each other accountable for their contributions. Implementing cooperative base groups in such a way that students meet regularly for the duration of a course completing cooperative learning tasks can provide the permanent support and caring that students need to make academic progress.

2.4.2 Benefits of cooperative learning

Effandi (2005) posits that cooperative learning represents a shift in education paradigm from teacher-centered approach to a more student-centered learning in small group. It creates excellent opportunities for students to engage in problem solving with the help of their group members.

Johnson, Johnson and Holubec (1994) proposed five essential elements of cooperative learning. These include positive interdependence; promote interaction, individual accountability, group processing and social skills. Positive interdependence means that the success of one learner is dependent on the success of the other learners. Promotive interaction is achieved by each individual helping each other, exchanging resources, challenging each other's conclusions, providing feedback, encouraging and striving for mutual benefits. Individual accountability is enhanced by teachers assessing the amount of effort that each member is contributing. This can be done by giving an individual test to each student and randomly calling students to present their group's work.

Cooperative learning has proved to be a successful instructional strategy. This is due to the fact that students can receive help and support from teachers, peers or tutors, the group members are more likely to provide social support for achievement and less likely to support "freeloaders". Cooperative learning encourages discussion and social interaction which in turn encourages meaningful information processing and elaboration; this facilitates long term memory encoding (Ormrod, 1995).

Lawrence and Kolawole (2007) posit that mathematics instruction should make extensive use of writing assignments, open-ended projects and cooperative learning groups. Students need to have opportunities to talk to each other about Mathematics. Students also need modes of instruction that are suitable for the increased emphasis on problem solving, applications and higher order thinking skills. Cooperative learning allows students to work together in problem-solving situations to pose questions, analyse situations, try alternative strategies and check for reasonableness of results.

According to Panitz (1996), cooperative learning promotes critical thinking skills. Clarification and explanation of one's answer is a very important part of collaborative process and represents a high order thinking skills. Felder (1997) posits that additional benefits occur when cooperative learning is used for instruction in that students' grades are improved, they show longer retention of information; transfer of information to other courses and disciplines is better and has a better class attendance. Cooperative learning helps the students to wean themselves away from considering teachers as the sole source of knowledge and understanding.

According to Johnson, Johnson and Holubec (1994), cooperative learning promotes interpersonal and small-group skills and therefore teachers must provide opportunities for group members to know, accept and support each other, communicate accurately and resolve differences constructively. Group processing enables group to focus on good working relationship, facilitates the learning of cooperative skills and ensures that members receive feedback.

2.5 Cooperative Learning Strategies

According to Dembo (1994), there are five most widely used cooperative learning strategies. These include: Group Investigation, Student Team-Achievement Divisions (STAD), Jigsaw, Teams-Assisted Individualization (TAI) and Teams-Games-Tournaments.

2.5.1 Group Investigation

According to Sharan (2006), group investigation involves students forming interest groups within which to plan and implement an investigation and synthesize the findings into a group presentation for the class. The teacher's general role is to make the students aware of resources that may be helpful while carrying out the investigation. It involves investigation, interaction, interpretation and intrinsic motivation. Investigation involves groups focusing on the process of inquiring about a chosen topic. Interaction, which is the hallmark of all cooperative learning methods, is required for students to explore ideas and help one another learn. Interpretation occurs when the group synthesizes and elaborates on the findings of each member in order to enhance understanding and clarity of ideas. Groups conduct their presentations as the teacher and students evaluate the investigation and resulting presentations. Finally, intrinsic motivation is kindled in students by granting them autonomy in the investigative process.

2.5.2 Student Teams –Achievement Divisions (STAD)

In this case students are assigned to four- member learning teams that are mixed in performance level, gender and ethnicity. STAD is based on students' previous performance, teachers assign students to one of several equal-status achievement divisions and weekly test results are compared only to each student assigned academically similar division. Thus, the test scores are converted into points that each student brings back to his/her team and the team with the highest points is considered the weekly winner of the inter-group competition. A teacher presents materials in the same way he/she always does, and then students work within their groups to make sure all of them mastered the content. All students take individual quizzes and students earn team points based on how well they scored on the quiz compared to past performance. A teacher presents a lesson and then students work within their teams to make sure that all team members have mastered the lesson. Finally, all students take quizzes on the material at which time they may not help one another. Students' quiz scores are compared to their own past averages and points are awarded on the basis of the degree to which students meet or exceed their own earlier performance. These points are then summed up to form team scores and teams that meet certain criteria may earn certificates or other rewards (Slavin, 1994).

2.5.3 Jigsaw Cooperative Learning Strategy

This is a cooperative learning strategy whereby Jigsaw groups are developed in the class and each student in the group is assigned his /her part to work on. The groups are then reconstituted to form expert groups with students having identical assignment put together. The teacher gives the expert groups time to discuss their specific tasks. Then the students go back to their initial Jigsaw groups to present their well-organized report to the group. The teacher floats from group to group observing the process and if there is any trouble the teacher makes an intervention (Aronson, 2000).

2.5.4 Teams Assisted Individualization

According to Slavin (1995), this is a cooperative learning strategy in which students are split into teams of four or five with mixed ability. After a teacher has taught a lesson, team mates help each other complete the exercises. Students are then given exercises at a level determined by their scores in an initial test. Students earn recognition by way of weekly awards for their overall performance.

2.5.5 Teams-Games-Tournaments Cooperative Learning Strategy

Teams-Games-Tournaments (TGT) was originally developed by DeVries and Edwards (1972) at the Johns Hopkins University. It is a type of cooperative learning method where students compete with members of other teams to contribute points to their team score. Students compete in at least three persons "tournament tables" against others with a similar past record in mathematics. After that, a procedure changes to table assignments to keep the competition fair. The winner at each tournament table brings the same number of points to his or her team, regardless of which table it is; this means that low achievers and high achievers have an equal opportunity for success. High performing teams earn team rewards.

According to Effandi and Zanaton (2007), TGTCLS has three basic elements: teams in which students are assigned to heterogeneous teams of equal sizes, games where skill exercises relating to content material are played during weekly tournaments and tournament in which students represent their teams and compete individually against students from other teams. The winnings are brought back to their teams. Total winnings are tallied across teams and team champions are announced. TGTCLS helps students review what they have just learned in the unit for a future test. There is an incentive for playing the game. The team that wins the tournament gets a reward such as stickers or extra time to play outside.

A study conducted by Chambers and Abrami (1991) in Montreal Canada, observed the effects of the TGT technique on students' individual outcomes, team outcomes and academic achievement perceptions of students. They found that students who were members of successful teams performed better on the individually completed test than members of unsuccessful teams.

Ke and Grabowski (2007) conducted an experimental study in America on the effects of game playing (TGT cooperative game playing, interpersonal competitive game playing, and no game playing) on two criterion measures (standards-based math exam performance and attitudes). They found that mathematics game playing did promote test-based cognitive learning achievement.

Salam, Hosain and Rahman (2015) conducted a study on the effects of using Teams Games Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Bangladesh. They found that students who were taught using Teams Games Tournaments cooperative learning performed better in mathematics as compared to those taught using lecture method.

According to Awofala, Fatade and Ala-Oluwa (2012), TGT tournaments are held weekly and are made up of short-answer questions. The sum of the team points, to which each team member contributes, is used to determine which team wins the tournament, and thus maintaining "reward interdependence" within each practice team.

According to DeVries and Edwards (1972), the procedure of implementing Teams-Games-Tournaments Cooperative Learning Strategy involves the following eight steps:
Step 1: Divide the class into teams of four or five. A class of 45 students would have 9 teams. A class of 44 would have 8 teams of 5 and one team of 4.

Step 2: Distribute the practice version of the test to each student and instruct them to answer the questions cooperatively as a team, ensuring that all team members understand how each answer was obtained. The intention is to lift the overall team performance.
Step 3: Display the answers on the overhead projector or blackboard and get each team to check their answers and resolve any issues with their answers.
Step 4: Ask the students to sort their team on the basis of their understanding of the topic from very good understanding (A students) to poor understanding (E students).
Step 5: Regroup and seat all the A students in one area of the room, B students in another area and so on.
Step 6: Give the test version questions to each student and instruct them to individually answer the questions under formal test conditions.
Step 7: Display a copy of the answers on the overhead projector or blackboard and get each student to mark their answers and then rank themselves amongst the group of students they are grouped with. That is, A students will rank themselves from best to worst score. If there are five A students, then the student with the best score is given a score of 5 points while the student with the lowest score is given a score of 1 point. Students with equal scores receive the same number of points e.g. the distribution could be 5, 4,4,4,1 if three students have the same score. If there are only four students in the group, the scores will range from 5 to 2 points.
Step 8: The students recombine into their original teams and total their scores with the largest score winning. Any team with less than 5 students adds the average grade for the team to their score.

This study intends to explore the instructional potential of using Teams-Games-Tournaments Cooperative Learning Strategy in students' mathematics achievement, self-concept and perception of classroom learning environment in public secondary schools in Nyeri Sub-County, Kenya.

2.6 Mathematics Students' Self-Concept

Self-concept is the image that we have of ourselves. This image is formed in a number of ways, but is particularly influenced by our interactions with important people in our lives. Self-concept is our perception or image of our abilities and our uniqueness. At first one's self-concept is very general and changeable. As we grow older, these self-perceptions become much more organized, detailed and specific (Pastorino & Doyle-Portillo, 2013).

Self-concept is a collection of beliefs about one's own nature, unique qualities and typical behavior. Your self-concept is your mental picture of yourself. It is a collection of self-perception (Weiten, Dunn, & Hammer, 2012). Self-concept is the totality of our beliefs, preferences, opinions and attitudes organized in a systematic manner, towards our personal existence. Simply put, it is how we think of ourselves and how we should think, behave and act out our various life roles (Sincero, 2012).

According to Githua (2002), individuals change their self-concept with change in cognitive development, social situations, interactions with parents, peers, teachers and institutions such as home and schools. Self-concept is evaluative in that individuals evaluate themselves in given situations. For example, within a Mathematics classroom a student may have low self-esteem but could surprisingly have very high self-esteem during Geography lessons.

Marsh (1990) indicated that there are four non-academic facets of self-concept and three facets of academic self-concept that make up a person's general self-concept. The non-academic facets include physical abilities, physical appearance, opposite sex relations, same sex relations, parent relation, honesty (trustworthiness) and emotional stability. The academic domains include Mathematics, verbal and general school. Figure 2 shows the representation of the various domains of self-concept.

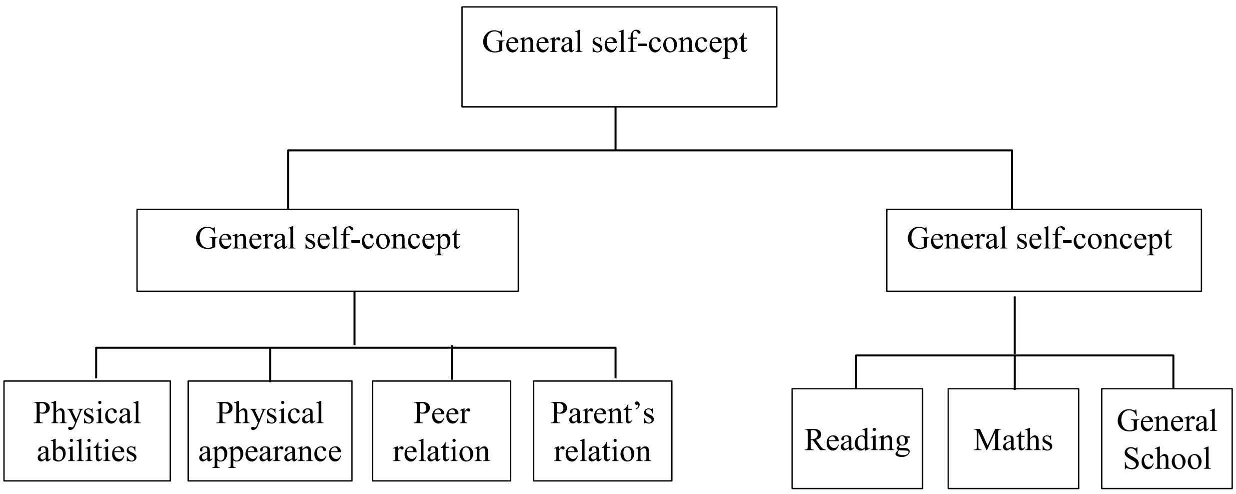


Figure 2. Hierarchical Domains of Self-Concept
Source: Adapted from Githua (2002)

Self-concept of ability can be changed in specific subject areas such as Mathematics. According to Marsh (1990), mathematics self-concept is one's perceived personal mathematical skill, ability, reasoning ability, enjoyment and interest in mathematics. A target group is first identified then goals are set while teaching materials, relevant teaching activities, learning experiences, learning methods, evaluation procedures and time frame for intervention are determined. Self-concept of ability in specific subject content is measured before and after an intervention.

Marsh (1993) indicated that maximizing self-concept of ability in an academic subject is recognized as a critical goal in itself and a means to facilitate the attainment of other desirable outcomes in education such as academic effort and persistence at tasks, attributions to failure or success, educational aspirations, academic achievement, course work selection, completion of high school and subsequent university attendance. Trautwein, Ludtke, Nagy and Marsh (2009) argued that children and adolescents begin integrating social comparison information into their own self-concept in elementary school by assessing their position among their peers. A study by Rawlinson (2012) found that through exchange of ideas, learners learn to negotiate with others and evaluate their contribution in socially acceptable manner. With social approval the learner increased self-concept. TGTCLS emphasized on collaboration and exchange of ideas which increased learners' social and communication skills and thus it developed positive effect on the students' mathematics self- concept.

Nawaz, Malik and Khan (2015), conducted a research on the effect of cooperative learning and lecture-demonstration method on self -concept of students at the elementary school level in Pakistan. The study investigated the effect on academic facets of self- concept namely reading, maths and general school. Results of the study showed that cooperative learning method was better than lecture method in the students' academic self-concepts. In this study, the researcher investigated the effect of TGT Cooperative Learning Strategy on students' mathematics self-concept in public secondary schools in Nyeri Sub-County, Kenya.

2.7 Mathematics Classroom Learning Environment

The goal of classroom activities is to learn mathematics but the learner could be reacting to a variety of stimuli in the classroom. In effective mathematics learning environment, a teacher is the facilitator of learning and uses a variety of instructional strategies. Assessment is varied, ongoing and effective since there are multiple types of formative and summative assessments.

Students are engaged in their learning by being actively involved in all aspects of a lesson. Students work with a variety of materials and technologies to construct meaning of mathematical ideas. A conducive learning environment is an important determinant of students' achievement in mathematics and sciences. Students' perception about science and mathematics might be negatively affected by the way a teacher presents the subject matter (Kiboss, 1997).

According to Protheroe (2007), an effective mathematics classroom is one that students are actively engaged in doing mathematics not watching others do the mathematics for them or in front of them solving challenging problems. It is essential that students have the opportunity to discuss mathematics with one another, refining and critiquing each other's ideas and understandings. Communication can occur through paired work, small group work, or class presentations.

Lawrence and Kolawole (2007) posit that students need a non-threatening environment in which they are encouraged to ask questions and take risks. The learning climate should incorporate high expectations for all students, regardless of sex, race, handicapping condition or socio-economic status.

According to Craven and Penick (2001) constructivist learning environment is one that students are given an opportunity to communicate their understandings with other students, to generate plausible explanations for phenomena, to test, evaluate and defend their evaluations among their peers, and are actively engaged in the social construction of knowledge. Students are provided frequent opportunities to identify their own learning goals, to share control of the learning environment and to develop and employ assessment criteria within the learning environment. Positive classroom environments are associated with a range of important outcomes for students. Environment and social systems influence behavior through psychological mechanisms of the self-esteem such as aspirations/motives, emotional states among others (Pajares, 2002). In an effective mathematics classroom, a teacher demonstrates acceptance of students' divergent ideas, influences learning by posing challenging and interesting questions and projects a positive attitude about mathematics (Protheroe, 2007).

Classroom interaction is an important determinant of student achievement in mathematics. Kirembu (1991) found that the nature and quality of classroom interaction is vital for good performance. This involves reciprocal contacts between a teacher and a learner whose interchange leads to meaningful teaching and learning. Kiboss (1997) established that classroom environments that provide opportunities for interactions often result into meaningful learning. Therefore, the more interactive student and teacher are, the better the students' performance. A constructivist learning environment is one in which learning is driven by the problem to be solved; students learn the content and theory in order to solve the problem. Instructors therefore need to provide an authentic context for tasks, plus information resources, cognitive tools and collaborative tools (Jonassen, 1999).

Remillard (2015) conducted a study on the effect of cooperative learning on middle school mathematics students in 6th - 8th grades in Central Washington State and found that students who were taught using cooperative learning strategies were more motivated and engaged in the classroom activities. The results of the study showed that cooperative learning enhances students' interest, motivation, creativity and success. The results revealed that cooperative learning creates a more positive and tolerant mathematics classroom learning environment.

According to Effandi and Zanaton (2007), the purpose of the Teams-Games-Tournaments (TGT) strategy is to create an effective classroom environment in which students are actively involved in the learning process and are consistently receiving encouragement. Students' perception of mathematics classroom environment affects their achievement. Rajoo (2013) posit that by knowing students' perceptions, a teacher can formulate the best strategies to provide ideal mathematics classroom environment and ensure better performance in mathematics. In this study, the researcher investigated the effect of TGT Cooperative Learning Strategy on students' perception of mathematics classroom learning environment in Kenyan secondary schools.

2.8 Theoretical Framework

The study was based on Piaget constructivist learning theory of cognitive development. According to Piaget, conceptual changes in children emerge as a result of people's action in the world or experience in conjunction with a host of hidden processes. The implications are children interpret what they hear in the light of their knowledge and experience that is, teaching is always indirect, knowledge is not information to be delivered at one end and encoded, memorized, retrieved and applied on the other end and knowledge is experience that is acquired through interaction with world, people and things (Piaget, 1972).

Constructivist learning theory states that learning is an active process of creating meaning from different experiences and that students learn best by trying to make sense of something on their own with a teacher as a guide to help them along the way. Constructivist teaching is based on constructivist theory with the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information (Thirteen Ed Online, 2004).

According to VonGlaserfeld (1991), there are three basic tenets of constructivist learning theory. First, all knowledge is constructed from pre-existing knowledge structures and that classroom activities such as discussions provide opportunities for students to use, revise and build upon previous knowledge. Secondly, knowledge construction is inherently social in nature and therefore the atmosphere should be socially interactive. Thirdly, dialogue plays an important role in knowledge construction. Students and teacher(s) converse with each other about the mathematics concept in the classroom. This means that a teacher is not the sole source of knowledge.

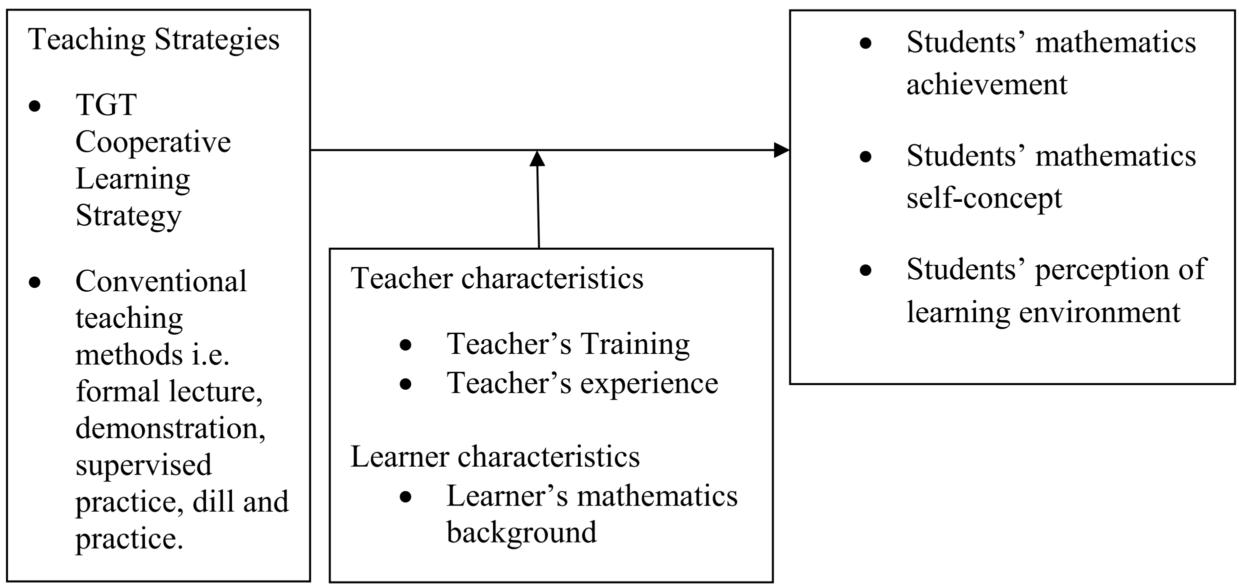
According to Steffe and Gale (1995), constructivism is a cognitive learning theory that integrates both social cognitive theory and information processing theory. Learning mathematics requires construction not passive reception. Seeing, hearing and remembering are all acts of constructivism in which students are active thinkers and knowledge is socially constructed. Teachers facilitate learning in which they are active participants and guides.

The study was also based on the theory of cognitive development by Vygotsky. According to Vygotsky (1978), children first develop lower mental functions such as simple perceptions, associative learning and involuntary attention; however, through social interactions with more knowledgeable others, such as peers and adults, children eventually develop higher mental functions such as language, counting, problem-solving skills, voluntary attention and memory schemas.

According to Doolittle (1995), Vygosky's theory of the zone of proximal development 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.

2.9 Conceptual Framework

The conceptual framework that guided this study was based on the Piaget's constructivist theory of learning which holds that learning is an active process where students are involved in meaningful construction of knowledge. The study was based on the assumption that a teaching strategy that actively involves students actively is more likely to lead to meaningful learning. The diagrammatic representation of the conceptual framework showing the relationship between the variables is illustrated in Figure 3.



Independent Variables **Extraneous Variables** **Dependent Variables**

Figure 3. 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. They include lecture, demonstration, questioning, discussion, supervised practice, drill and practice (Kiruhi, Githua & Mboroki, 2009).

The dependent variables in the study were the students' achievement in mathematics, students' self-concept and their perception of the classroom learning environment. The extraneous variables included the teacher and learner characteristics and could have influenced the results of the study unless controlled. Teacher characteristics were in terms of personality, training and experience while the learner characteristics were in terms of student's Mathematics background. Teachers' personality affects the instruction process. Teacher training equips the teacher with adequate content on the subject matter. Teacher training affects his/her ability to create meaningful learning experiences. Teacher experience enables the teacher to see the strengths and weaknesses of the instructional approaches used in teaching the subject which affects his/ her ability to appropriately implement the curriculum (Mutange, 2006).

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. 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.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a description and rationale of the research methodology used. It describes the research design, location of the study, population of the study, sampling procedure and sample size, instrumentation, data collection procedures and data analysis. It also presents a summary of statistical tests that were used in the testing of the hypotheses.

3.2 Research Design

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 overcomes external validity weaknesses found in other designs since it provides adequate control of other variables that may contaminate the validity of the study. It assesses the interaction between pretest and treatment conditions. It also helps to assess the effect of the pretest relative to no pretest and also assess the homogeneity of the groups before administration of the treatment. Figure 4 illustrates the research design used in the study.

Groups	Pretest	Treatment	Posttest
E_1	O_1	X (TGT Cooperative Learning Strategy)	O_2
C_1	O_3	C (conventional teaching methods)	O_4
E_2		X (TGT Cooperative Learning Strategy)	O_5
C_2		C (conventional teaching methods)	O_6

Figure 4. The Research Design

Source: Adapted from Gilbbon and Herman (1997).

Four groups of subjects were used in the study. These were: the experimental group one (E_1), the control group one (C_1), the experimental group two (E_2) and the control group two (C_2).

Classes were assigned randomly to four groups. Groups E_1 and E_2 received the treatment (X) which involved being taught by use of TGT Cooperative Learning Strategy. The Control Groups C_1 and C_2 were taught using Conventional Teaching Methods which involve the traditional formal lecture, instructor-directed activities and problem-solving strategies. The experimental group E1 and the control group C1 received a pretest (O1) 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.

Shama (2002) noted that it is important that the groups be as similar as possible and that there is opportunity for both a pretest and posttest in both the treatment and the control groups. To control interaction between selection and instrumentation, the instruments were administered at the same time across the groups.

3.3 Location of the Study

The study was conducted in Nyeri Central Sub-County which is located in Nyeri County, Central Kenya. The Sub-County has 2 educational zones: Nyeri Municipality North and Nyeri Municipality South Zones. The Sub-County has 27 secondary schools which are categorized into National, Extra-County, County, Sub-County and Privately Owned secondary schools. The Sub-County has 20 public secondary schools which include one national school, two single sex extra-county schools, two single sex county schools and sixteen Sub-County schools. There are seven privately owned secondary schools. The location was chosen because students' performance in Mathematics was dismal as shown in Table 2.

3.4 Population of the Study

The target population was all secondary school students in Nyeri Central Sub-County. The total student population was 9,357 students. Nyeri Municipality North and Nyeri Municipality South Zones had a student population of 5,556 and 3,801 respectively. The accessible population was Form Two students in public secondary schools in Nyeri Central Sub-County. There were about 2510 Form Two students in Nyeri Central Sub-County. Form Two students were involved in the study because the mathematics topic 'Similarty and Enlargement' is taught at this level (KIE, 2002). Public co-educational Sub-County schools were selected because they have similar learning environment and these schools have students who have comparable academic abilities based on the KCPE examination performance (Sub-County Education office, Nyeri Central Sub-County, 2016) thus providing a basis of generalization of the result.

Students from these schools represent the population of students with average academic ability as opposed to National and County secondary school students whose performance at KCSE examination is well above average.

3.5 Sampling Procedure and Sample Size

The sampling frame was the list of all the public co-educational Sub-County schools in Nyeri Central Sub-County. Simple random sampling by method of lottery was used to select two schools from each of the two educational zones. This ensured that each school was equally likely to be chosen as part of the study sample and schools would be far apart to minimize interaction between the groups (Mugenda & Mugenda, 2003). The assignment of groups to either experimental or control groups was done by simple random sampling. Each selected school formed a group in the Solomon 4 group design. The number of students in the Experimental groups E1 and E2 was 45 and 40 respectively. The control groups C1 and C2 had 58 and 37 students respectively. Each of the four groups attained the threshold of at least 30 students per group are required for experimental research (Mugenda & Mugenda 2003). The sample size of the study was 180 students.

3.6 Instrumentation

Mathematics Achievement Test (MAT) was used to assess students' mathematics achievement. Mathematics Self-Concept Questionnaire (MSCQ) and Mathematics Learning Environment Questionnaire (MLEQ) were used to assess students' self-concept and perception of the mathematics classroom learning environment respectively.

3.6.1 Mathematics Achievement Test (MAT)

The researcher developed MAT which consisted of fourteen items from the topic 'Similarity and Enlargement'. Minimum and maximum scores were 0 and 60 respectively (Appendix 3). The test items were developed using a Table of Specification as shown in Table 4.

Table 4

Table of Specification for MAT

Number of Items in each Cognitive Level				
	Content Area			
	Remembering	**Understanding**	**Applying**	**Total**
Similar figures	1	1	0	**2**
Enlargement	0	3	1	**4**
Area scale factor	0	1	1	**2**
Volume scale factor	0	3	2	**5**
Real life situations	0	0	1	**1**
Total	**1**	**8**	**5**	**14**

The test items constituted the three lowest levels of the cognitive domains which include remembering, understanding and applying (Anderson & Krathwohl, 2001). This test was administered to experimental group E1 and control group C1 as the pretest. It was also administered to all the four groups in the study as the posttest to assess students' achievement after intervention.

3.6.2 Mathematics Self-Concept Questionnaire (MSCQ)

MSCQ was used to assess students' self-concept. The Self Descriptive Questionnaire II developed and used by Marsh (1990) was adapted to suit the study. The instrument is designed to measure self-concept in adolescents. It is the most validated self-concept measure available for use with adolescents. The self-descriptive questionnaire is specifically designed to measure the eleven facets of self-concept. These include the four non-academic areas (Physical Ability, Physical Appearance, Peer Relations and Parents Relations), three academic areas (Verbal Mathematics and School in general) and a global perception of self (Honesty, Same-sex Relations and Opposite-Sex Relations for males only, Same-sex Relations and Opposite-Sex Relations for females only). For the purpose of this study, the researcher used the items that measure student's mathematics self-concept.

In this study, MSCQ had twenty items and their responses ranged from: Strongly Disagree, Disagree, Uncertain, Agree and Strongly Agree (a five-point Likert scale) which can easily be understood and interpreted by the respondents (See Appendix 4). Scoring rule in the analysis of MSCQ scores was: strongly agree = 5 points, agree = 4 points, uncertain =3 points, disagree = 2 points, strongly disagree = 1 point. For the items that were directional inversed, scoring rule was reversed: strongly agree = 1 point, agree = 2 points, uncertain = 3 points, disagree = 4 points and strongly disagree = 5 points. Scores of the students' responses to the items were summed up and an overall mean score for each group was computed. This questionnaire was administered to experimental group E_1 and control group C_1 before teaching the topic 'Similarity and Enlargement' to assess the learners' mathematics self-concept. It was also administered to all the four groups in the study after the intervention.

3.6.3 Mathematics Learning Environment Questionnaire (MLEQ)

MLEQ was used to assess students' perception of the mathematics classroom learning environment. The students' perception of the classroom learning environment questionnaire in physics developed and used by Kiboss (1997) was modified to suit the study. It consisted of nineteen items and their responses ranged from: Strongly Disagree, Disagree, Uncertain, Agree and Strongly Agree (a five-point Likert scale) which can easily be understood and interpreted by the respondents (See Appendix 5). The instrument addressed the mode of instruction, time adequacy, learning provisions, instructional materials, teachers' and learners' activities. Scoring rule in the analysis of MLEQ scores was: strongly agree = 5 points, agree = 4 points, uncertain =3 points, disagree = 2 points, strongly disagree = 1point. For the items that were directional inversed, scoring rule was reversed: strongly agree = 1 point, agree = 2 points, uncertain = 3 points, disagree = 4 points and strongly disagree = 5 points. Scores of the student's responses to the items were summed up and an overall mean score for each group was computed. This questionnaire was administered to experimental group E_1 and control group C_1 before teaching the topic 'Similarity and Enlargement' to assess the learners' perception of mathematics classroom learning environment. It was also administered to all the four groups in the study after intervention.

3.6.4 Validation of the Research Instruments

Validity is the degree to which results obtained from analysis of data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). According to Fraenkel and Wallen, (2000), validity as the degree to which correct inferences can be based on results from an instrument; depends not only on the instrument itself but also on the instrumentation process and the characteristics of the group studied. According to Bryan (2012), validity is concerned with the integrity of the conclusions that are generated by a piece of research. Prior to the study, MAT, MSCQ and MLEQ were validated by four experts in Educational Research in the Department of Curriculum, Instruction and Educational Management, Egerton University. Three secondary school mathematics teachers who are KCSE examiners also validated MAT. They assessed the instruments in terms of content and face validity. Their comments were incorporated into the instruments before the administration of the instruments on the participants of the study. The items in the instruments were accurate and comprehensive enough to provide adequate data required for the study.

3.6.5 Reliability of the Research Instruments

According to Tavakol and Dennic (2011), reliability is a measure of the degree to which a research instrument yields consistent results or data after a repeated trial. Reliability ensures there is precision with which data is collected. If the same results are gained time after time, no matter how many times you conduct a piece of research, this suggests that the data collected is reliable (Mugenda & Mugenda, 2003). Fraenkel and Wallen (2000) define reliability as the degree to which scores obtained with an instrument are consistent measure of whatever the instrument measures. Bryan (2012) argued that reliability is concerned with the question of whether the results of a study are repeatable. In this study pilot testing of the instruments was conducted in a randomly selected Sub-County secondary school in the neighboring Tetu Sub-County. The Sub-County was chosen because it has similar characteristics with Nyeri Central Sub-County. This ensured validity and reliability of the instruments. According to Cohen, Manion and Morrison (2007), the pilot testing will guard against using unreliable tests or instruments that can introduce serious errors in the experiments.

Reliability of the three instruments was estimated using the Cronbach Alpha Coefficient formula:

$$\mathrm{A} = \frac{K}{K-1}\{1 - \frac{\Sigma s_{\mathrm{i}}{}^{2}}{s_{\mathrm{x}}{}^{2}}\}$$

Where k = Number of items

$\Sigma s_{\mathrm{i}}{}^{2}$ = Sum of the variances of the individual items

$s_{\mathrm{x}}{}^{2}$= Variance of the total test scores

Cronbach Alpha Coefficient was used to estimate the reliability of MAT, MSCQ and MLEQ since the items were not scored dichotomously. The Cronbach Alpha Coefficient was also used because it determines the reliability of an instrument by a single administration and can assess the homogeneity of the items. The instruments are deemed to be reliable if the reliability coefficient is at least 0.70 (Gall, Gall & Borg, 2007). MAT, MSCQ and MLEQ were reliable since they had a reliability coefficient of 0.850, 0.782 and 0.861 respectively.

3.7 Data Collection Procedure

Before collecting data, the researcher sought the research permit from the National Commission for Science, Technology and Innovation (NACOSTI) through the Graduate school, Egerton University. After the authority was granted, the researcher visited Nyeri County Director of Education and was granted written permission to conduct the research in the county. The researcher then visited the sampled secondary schools and obtained permission from the schools' Principals to carry out the research with the assistance of the mathematics teachers in the sampled schools. To generate required data for this study, teachers involved in teaching the experimental groups underwent a one-week in-service training on teaching mathematics using TGT Cooperative Learning Strategy. MAT, MSCQ and MLEQ was first administered to students in experimental group E_1 and control group C_1 to ascertain their entry level and homogeneity. Experimental groups E_1 and E_2 were taught the topic 'Similarity and Enlargement 'using TGT Cooperative Learning Strategy while groups C_1 and C_2 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, MSCQ and MLEQ at the same time. Collected data was scored and coded for analysis.

3.8 Procedure for Implementation of TGTCLS

In this study, the procedure for implementing the Teams-Games-Tournaments Cooperative Learning Strategy involved the following eight steps:

Step 1: The teacher divided the experimental groups E1 and E2 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 by the teacher 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 by the teacher on the chalkboard 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 weekly and are made up of short-answer questions. In this study two tournaments were held fortnightly and this allowed sufficient time for coverage of the content. The sum of the team points, to which each team member contributed, was used to determine which team won the tournament, and this maintained “reward interdependence” within each practice team.

3.9 Data Analysis

In this study, quantitative data was generated. Data collected was analysed with the aid of Statistical Package for Social Sciences (SPSS) Version 20. Descriptive (mean and standard deviation) and inferential statistics (t- Test and One-way ANOVA) were used to analyze data collected. The independent sample t-Test was used to analyze the difference between two means in the pre-test for groups E_1 and C_1. A t-Test was used because of its superior quality in detecting differences between two groups (Gall, Gall & Borg, 2007). This was to test the characteristics of the subjects before intervention. Scores obtained from the post-test were analyzed using One-way Analysis of Variance (ANOVA) because there were more than two groups. ANOVA was also used to test whether there were significant differences in the self-concept scores and perception of classroom learning environment scores between students exposed to TGTCLS and those exposed to conventional teaching methods. A summary of the statistical methods that were used for data analysis is shown in Table 5.

Table 5

Summary of the Statistical Methods of Data Analysis

Hypotheses	**Independent variables**	**Dependent variables**	**Statistical tests**
Ho1: There is no statistically significant difference in Mathematics Achievement between the students who are taught using TGTCLS and those taught using CTM.	TGTCLS CTM	Students' Mathematics Achievement Tests (MAT) scores	One-way ANOVA Independent sample t-Test
Ho2: There is no statistically significant difference in Mathematics Self-Concept between the students who are taught using TGTCLS and those taught using CTM.	TGTCLS CTM	Self-concept scores in Mathematics Self-Concept Questionnaire (MSCQ)	One-way ANOVA Independent sample t-Test
Ho3: There is no statistically significant difference in the Perception of Mathematics Classroom Learning Environment between the students who are taught using TGTCLS and those taught using CTM.	TGTCLS CTM	Perception scores in Mathematics Classroom Learning Environment Questionnaire (MLEQ)	One-way ANOVA Independent sample t-Test

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results of the pre-test and post-test in form of tables. The results are analysed using both descriptive and inferential statistics.

The following null hypotheses were tested at Alpha (α) = 0.05 level of significance.

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.

Ho2: There is no statistically significant difference in mathematics self-concept between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

Ho3: There is no statistically significant difference in students' perception of the mathematics classroom learning environment between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods.

For each of the three hypotheses, discussions are presented based on the analysed results.

4.2 Results of the Pre-test

A pretest analysis was conducted to establish the students' entry behavior by comparing their MAT, MSCQ and MLEQ scores before intervention. According to Gall, Gall and Borg (2007), pre-testing helps a study to gather information on the characteristics of the subjects at the beginning of a programme. This information helps a researcher to come up with valid and objective conclusions about the population at the end of the study. Experimental group E1 and control group C1 were subjected to the pretest in line with the requirements of the Solomon Four Quasi-Experimental research design.

Independent sample t-tests were undertaken to determine whether there was statistically significant difference between E1 and C1 at α = 0.05 level of significance. Table 6 shows the analysis of the results of the pretest.

Table 6

Independent sample t-test of the Pre-test Scores on MAT, MSCQ and MLEQ

Scale	Group	N	Mean	SD	Df	t-value	P-value
MAT (maximum = 60)	E1	45	1.93	2.14	96	.386	.701
	C1	53	1.78	1.70			
MSCQ (maximum = 5)	E1	45	3.20	0.78	95	1.706	.092
	C1	52	2.95	0.59			
MLEQ (maximum = 5)	E1	45	3.49	0.40	100	1.584	.116
	C1	57	3.36	0.42			

The results of Table 6 indicate that MAT pretest mean, $M = 1.93$, of E1 was higher than $M = 1.78$ of C1. The results also indicates that the difference between the two means was not statistically significant, $t(96) = 0.386$, $p > 0.05$. The results in Table 6 show that the difference between MSCQ mean ($M = 3.20$, $SD = 0.78$) of E1 and that ($M = 2.95$, $SD = 0.59$) of C1 was not statistically significant, $t(95) = 1.706$, $p > 0.05$. The results in Table 6 further reveal that MLEQ mean ($M = 3.49$, $SD = 0.40$) of E1 and that ($M = 3.36$, $SD = 0.42$) of C1 was not statistically significant, $t(100) = 1.584$, $p > 0.05$. The results in the table imply that the two groups E1 and C1 exhibited comparable characteristics and thus suitable for the study.

4.3 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 first objective of the study sought to determine whether there was a statistically significant difference in mathematics achievement between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods. The post-test means scores and standard deviations of the groups are summarized in Table 7.

Table 7

MAT Post-test Mean Scores

Group	N	Mean	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

The results in the Table 7 indicate that the mean scores of the experimental groups E1 and E2 were 18.91 and 20.55 respectively. Control groups C1 and C2 had mean scores of 14.94 and 14.12 respectively. The results show that the posttest mean scores of the experimental groups (E1 and E2) were higher than those of the control groups (C1 and C2). There was a marked difference in the achievement between the groups which were exposed to TGTCLS and those taught using CTM. This shows that TGTCLS had an effect of enhancing achievement in mathematics as compared to CTM. To establish whether the MAT mean scores were statistically significantly different, One-way ANOVA was done and the results are shown in Table 8.

Table 8

One-way ANOVA of the MAT Posttest mean scores by Learning Approach

Scale	Sum of Squares	Df	Mean Square	F-ratio	p-value
Between Groups	1206.259	3	402.086	9.018	.000*
Within Groups	7624.621	171	44.588		
Total	8830.880	174			

* Statistically Significant at Alpha (α) = 0.05. $P < .05$

The results in Table 8 reveal that the difference in MAT post-test means of groups E1, E2, C1 and C2 were statistically significant, $F(3,171) = 9.018$, $p = .000$. The differences among the groups were statistically significant. There was need for the multiple comparison (Post Hoc) tests to reveal where the differences were. As such, a further analysis using Scheffe's post Hoc a 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 multiple comparison tests are given in Table 9.

Table 9

Multiple comparison of MAT Posttest Mean scores by Learning Approach

Learning Method I	Learning Method J	Mean Difference (I-J)	SE	P-Value
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
C2	E1	-4.79*	1.52	0.022
	C1	-0.72	1.47	0.971
	E2	-6.43*	1.57	0.001

* Statistically Significant at Alpha (α) = 0.05. $P < .05$

The results of the Table 9 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.

MAT Mean Gain analysis by Learning Approach

Gain made by learners is the difference between the pre-test and post-test mean scores. The gain (referred to as paired difference) gives an indication of the relative effects of treatment on study groups. The gains of E1 and C1 were determined and used to explain improvements in learning outcomes. Results of the mean gain analysis are shown in Table 10.

Table 10

Students' MAT Mean Gains by Learning Approach

		Group	
Stage	**Scale**	**E1 (N = 45)**	**C1 (N = 53)**
Pre-test	Mean	1.93	1.78
	Standard Deviation	2.14	1.71
Post –test	Mean	18.91	14.84
	Standard Deviation	7.94	4.31
	Mean Gain	**16.98**	**13.06**

Results in Table 10 indicate that the experimental group E1 had a mean of 1.93 and 18.91 in the pretest and post-test respectively. This means that the mean gain was 16.98. The control group CI had a mean of 1.78 and 14.48 in the pretest and post-test respectively. This means that the mean gain was 13.06. This implies that 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 conventional teaching methods.

4.4 Effects of TGTCLS on Mathematics Self- Concept

To determine the relative effect on students' mathematics self-concept an analysis of the students' post-test scores was carried out. The second objective of the study sought to determine whether there was a statistically significant difference in mathematics self-concept between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods. The differences were established by comparing the students' mathematics self-concept posttest mean scores among groups; E1, C1, E2 and C2. The posttest means scores and standard deviations of the groups are summarized in Table 11.

Table 11

MSCQ Post-test Mean Scores

Group	N	Mean	Standard Deviation
E1	39	3.44	0.65
E2	40	3.51	0.62
C1	57	3.04	0.61
C2	36	3.13	0.59

Results in Table 11 indicate that the post-test means of the four groups were relatively high as they were in the range of 3.04 (SD = 0.61) and 3.51 (SD = 0.62) out of a maximum of 5. The results indicate that the mean (M = 3.44, SD = 0.65) of E1 and that (M = 3.51, SD = 0.62) of E2 were higher than those of C1 (M = 3.04, SD = 0.61) and C2 (M = 3.13, SD = 0.59). ANOVA test was conducted to determine the differences in mathematics self-concept among the study groups C1, E1, C2 and E2, by learning strategy. ANOVA results are summarized in Table 12.

Table 12

One -way ANOVA of MSCQ Post-test Scores by Learning Approach

Scale	Sum of Squares	Df	Mean Square	F- ratio	P-value
Between Groups	7.229	3	2.410	6.356	.000*
Within Groups	63.695	168	0.379		
Total	70.925	171			

* Statistically Significant at Alpha (α) = 0.05. P < .05

Results in Table 12 reveals that the difference among the four sampled groups E1, C1, E2, and C2 was statistically significant, $F(3, 168) = 6.356$, $p = .000$. This is an indication that at the end of the study, the groups were not homogeneous. The multiple comparison test was conducted to establish where the difference among the four sampled groups occurred. The results of the Scheffe’s multiple comparison tests are given in Table 13.

Table 13

Multiple comparison of MSCQ Post-test Mean scores

Learning Method I	Learning Method J	Mean Difference (I-J)	SE	P-Value
E1	C1	0.40*	0.13	0.028
	E2	-0.07	0.14	0.966
	C2	0.31*	0.14	0.024
C1	E1	-0.40*	0.13	0.023
	E2	-0.47*	0.13	0.004
	C2	-0.09	0.13	0.933
E2	E1	0.07	0.14	0.966
	C1	0.47*	0.13	0.004
	C2	0.39*	0.14	0.006
C2	E1	-0.31*	0.14	0.024
	C1	0.09	0.13	0.933
	E2	-0.39*	0.14	0.006

* Statistically Significant at Alpha (α) = 0.05. $P < .05$

The results in Table 13 indicate that the difference between pair groups E1-C1 ($p < .05$), E1-C2 ($p< .05$), E2-C1 ($p < .05$) and E2-C2 ($p < .05$) were statistically significant. However, the differences between groups E1-E2 ($p > .05$) and C1-C2 ($p >.05$) were not statistically significant. 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 students' mathematics self-concept.

MSCQ Mean Gain Analysis

The mean gains in mathematics self-concept by learning approach of the groups E1 and C1 were determined as shown in Table 14 and used to explain improvements in learning outcomes.

Table 14

Students' MSCQ Mean Gains by Learning Approach

Stage	Scale	E1	C1
Pre-test	N	45	52
	Mean	3.20	2.95
	Standard Deviation	0.78	0.59
Post –test	N	39	57
	Mean	3.44	3.04
	Standard Deviation	0.65	0.62
	Mean Gain	**0.24**	**0.09**

Results in Table 14 indicate that the experimental group E1 had a mean of 3.20 and 3.44 in the pre-test and post-test respectively. The mean gain was therefore 0.24. The control group C1 had a mean of 2.95 and 3.04 in the pre-test and post-test respectively. The mean gain was therefore 0.09. This means that the level of mathematics self-concept in the group E1 which was exposed to TGTCLS was higher than that of the group C1 which was taught using the conventional teaching methods.

4.5 Effects of TGTCLS on Perception of Mathematics Classroom Learning Environment

To determine the relative effect of TGTCLS on the students' perception of mathematics classroom learning environment, an analysis of MLEQ posttest scores was carried out. The third objective of the study sought to determine whether there was a statistically significant difference in the perception of mathematics classroom learning environment between students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods. The differences were established by comparing the students MLEQ post-test mean scores among groups; E1, C1, E2 and C2. The post-test mean scores and standard deviations of the groups are summarized in Table 15.

Table 15

MLEQ Post-test Mean Scores

Group	N	Mean	Standard Deviation
E1	39	3.91	0.71
E2	30	4.00	0.36
C1	58	3.50	0.60
C2	37	3.52	0.73

The results in Table 15 indicate that the posttest means of the four groups were relatively high as they were in the range of 3.50 (SD = 0.60) to 4.00 (SD = 0.36) out of a maximum of 5. The results indicate that the means (M = 3.91) of E1 and (M = 4.00) of E2 were higher than those of C1 (M = 3.50) and C2 (M = 3.52). One-way ANOVA was then used to compare the differences among the E1, E2, C1 and C2. The one - way ANOVA results of the test are shown in Table 16.

Table 16

One-way ANOVA of MLEQ Post- test mean scores

Scale	Sum of Squares	Df	Mean Square	F- ratio	p-value
Between Groups	7.732	3	2.577	6.565	.000*
Within Groups	62.817	160	.393		
Total	70.55	163			

* Statistically Significant at Alpha (α) = 0.05. P < .05

Results in Table 16 indicate that the difference among MLEQ post-test mean scores of the groups was statistically significant, $F(3, 160) = 6.565$, $p < .05$. The results of the ANOVA test showed that the differences among the groups were statistically significant. Scheffe's multiple comparison test was conducted to reveal where the differences were. Results are in Table 17.

Table 17

Multiple comparison of MLEQ Post-test Mean scores by Learning Approach

Learning Method I	Learning Method J	Mean Difference (I-J)	SE	P-Value
E1	C1	0.40*	0.13	0.028
	E2	-0.10	0.15	0.935
	C2	0.39*	0.14	0.006
C1	E1	-0.40*	0.13	0.028
	E2	-0.49*	0.14	0.008
	C2	-0.01	0.13	1.000
E2	E1	0.10	0.15	0.935
	C1	0.49*	0.14	0.008
	C2	0.49*	0.15	0.022
C2	E1	-0.39*	0.14	0.006
	C1	0.01	0.13	1.000
	E2	-0.49*	0.15	0.022

* Statistically Significant at Alpha (α) = 0.05. $P < .05$

The results in the Table 17 indicate that the difference in MLEQ 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 ($p > 0.05$) and groups C1 and C2 ($p > 0.05$). The results of the post-hoc show that there was a significant difference in favour of the experimental groups. This implies that TGTCLS enhanced positive effect on perception of mathematics classroom learning environment.

MLEQ Gain Analysis

The mean gains in perception of mathematics classroom environment by learning approach of the groups E1 and C1 were determined and used to explain improvements in learning outcomes. The mean gains are as shown in Table 18.

Table 18

Students' MLEQ Mean Gains by Learning Approach

Stage	Scale	E1	C1
Pre-test	N	45	57
	Mean	3.49	3.36
	Standard Deviation	0.40	0.42
Post –test	N	39	58
	Mean	3.91	3.51
	Standard Deviation	0.71	0.60
	Mean Gain	**0.42**	**0.15**

Results in Table 18 show that the experimental group E1 had a mean of 3.49 and 3.91 in the pre-test and post-test respectively. The mean gain was therefore 0.42. The control group C1 had a mean of 3.36 and 3.51 in the pre-test and post-test respectively. The mean gain was therefore 0.15. This means that the level of perception of mathematics classroom environment in the group E1 which was exposed to TGTCLS was higher than that of the group C1 which was taught using the conventional teaching methods.

4.6 Discussion

4.6.1 Effects of TGTCLS on Students' Mathematics Achievement

The results of the analysis of the MAT scores show that differences between the control and experimental groups were significant in favor of the Experimental groups. The results thus indicate that TGTCLS enhances students' achievement. On the basis of these results, the 1st 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 findings reveal that there was a significant difference in mathematics achievement between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods. 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 findings further confirm the results of a study conducted by Chambers and Abrami (1991) in Montreal Canada on the effects of the TGTCLS on students' individual outcomes, team outcomes and academic achievement perceptions of students. Students who were members of successful teams performed better on the individually completed test than members of unsuccessful teams.

4.6.2 Effects of TGTCLS on Mathematics Self- Concept

In this study, the differences in students' mathematics self- concept mean scores between the experimental groups and control groups were found to be statistically significant. On the basis of these results, the 2nd hypothesis suggesting that there was no statistically significant difference in students' mathematics self- concept between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods was rejected. Multiple comparison of MSCQ shows that there was generally a significant difference in mathematics self-concept between the experimental and control groups. These findings revealed that learners who were taught using TGTCLS were able to integrate social comparison information into their own self-concept in elementary school by assessing their position among their peers. The results confirm Rawlinsons (2012) assertion that by use of cooperative learning strategies learners exchange of ideas, learn to negotiate with others and evaluate their contribution in socially acceptable manner improved the learner's mathematics self-concept. TGTCLS emphasized on collaboration and exchange of ideas which increased learners' social and communication skills and thus it developed positive effect on the students' mathematics self- concept. The use of TGTCLS resulted in an increased students' self- concept due to the fact that the lessons were interesting and students interacted positively. TGTCLS encouraged the learners to be reflective and inquisitive and this led to improved academic performance.

The results further support a study conducted by Nawaz, Atta and Khan (2015) on the effect of cooperative learning and lecture-demonstration method on academic self -concepts of students at the elementary school level in Pakistan. Results of the study revealed that cooperative learning method was better than lecture method which is one of the conventional teaching methods used by most mathematics teachers in secondary schools. In addition, the findings of this study support the findings of the study by Githua (2002) that students' mathematics self-concept correlate positively with their mathematics achievement.

4.6.3 Effects of TGTCLS on Perception of Mathematics Classroom Learning Environment

Results of the analysis of the MLEQ scores show that differences between the control and experimental groups were significant in favor of the Experimental groups. On the basis of these results, the 3rd hypothesis suggesting that there was no statistically significant difference in students' perception of mathematics classroom environment between the students taught using TGT Cooperative Learning Strategy and those taught using conventional teaching methods was rejected. These results agree with the results of a study conducted by Effandi and Zanaton (2007) on the effects of using Teams Games Tournaments (TGT) Cooperative Technique for Learning Mathematics in Secondary Schools of Malaysia. TGTCLS created an effective classroom environment in which students were actively involved in the learning process and were consistently receiving encouragement. TGTCLS provided opportunities for interactions which resulted to meaningful learning and this enhanced improved academic performance. This is in agreement with Kiboss (1997) who found that there is a strong relationship between the learning environment and acquisition of necessary knowledge and skills.

The results also agree with the findings of the study conducted by Craven and Penick (2001) in that TGTCLS provided a constructivist learning environment where students were given an opportunity to communicate their understandings and defend their evaluations among their peers. The results thus indicate that TGTCLS enhances interaction and hence promotes positive students' perception of mathematics classroom environment. The results of this study further agree with those of a study conducted by Remillard (2015) on the effect of cooperative learning on middle school mathematics students in Central Washington State in that students who were taught using cooperative learning strategies were more motivated and engaged in the classroom activities. The results of the study showed that cooperative learning enhances students' interest, motivation, creativity and success and thus cooperative learning creates a more positive and tolerant mathematics classroom learning environment.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings and conclusions based on the three hypotheses that guided the study. Implications of the findings of the study in mathematics education are also discussed. Recommendations emanating from the findings of this study and suggestions on possible areas for further research are also outlined.

5.2 Summary of the Findings

The findings of the study are summarized in line with the pretest, posttest results, objectives and hypotheses. The following are the findings of the study:

(i) The results of the post- test mean scores on MAT for the four groups were significantly different. Experimental groups E1 and E2 had means of 18.91 and 20.55 respectively while the control groups C1 and C2 had means of 14.94 and 14.12 respectively. ANOVA results show that the difference in the mean scores between the four groups were significant. Scheffe's multiple comparison tests also revealed that there was a statistically significant difference in favour of the experimental groups. The results therefore indicate that TGTCLS improved students' mathematics achievement.

(ii) The results of the post- test mean scores on MSCQ for the four groups were significantly different. Experimental groups (E1 and E2) had mean scores of 3.44 and 3.51 respectively while and the control groups (C1 and C2) had means of 3.04 and 3.13 respectively. ANOVA results show that the difference in the mean scores between the four groups were significant. Scheffe's multiple comparison tests also revealed that there was a statistically significant difference in favour of the experimental groups. These results therefore indicate that TGTCLS had a positive effect on students' mathematic self- concept.

(iii) The results of the post- test mean scores on MLEQ for the four groups were significantly different. Experimental groups E1 and E2 had means of 3.91 and 4.00 respectively while the control groups C1 and C2 had means of 5.50 and 3.52 respectively. ANOVA results show that the differences in the mean scores between the four groups were significant. Scheffe's multiple comparison tests also revealed that there was a statistically significant difference in favour of the experimental groups. The results therefore indicate that TGTCLS had a positive effect on students' perception of mathematic classroom environment.

5.3 Conclusions

Based on the findings of the study, the following conclusions were made:

(i) TGTCLS had a significant effect on mathematics achievement among secondary school students. This implies that it facilitates learning of mathematics better than the conventional teaching methods.

(ii) TGTCLS promoted an environment that emphasized collaboration and exchange of ideas which increased learners' self-concept. Hence the strategy proved better in developing positive mathematics self-concept than CTM among secondary school students.

(iii) TGTCLS had a potential of encouraging students' participation in mathematics lesson and hence proved better in developing positive perception of mathematics learning environment than CTM among secondary school students.

5.4 Implications of the Study

Achievement in mathematics in the national examinations has been quite low. The findings of this study show that if TGTCLS is used in teaching mathematics, the performance of students would improve. This is due to the fact that the strategy creates excellent opportunities for students to encourage each other in problem solving with the help of their group members and also promotes critical thinking with the support of the teacher.

TGTCLS requires that students interact with their peers and teachers and this improves individual student's mathematics self-concept. The strategy also provides opportunity or the learners to discuss mathematical problems with one another, refining and critiquing each other's ideas and understanding. This creates an effective classroom learning environment.
The findings of this study have indicated that the use of Teams-Games-Tournament Cooperative Learning Strategy improves students' achievement in mathematics, self-concept and perception of classroom learning environment and hence the strategy should be incorporated into the teaching of mathematics at the secondary school level.

5.5 Recommendations

Based on the findings of this study, the following recommendations have been made:

(i) 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.

(ii) Mathematics curriculum developers, teacher training colleges and universities, should include the teaching of mathematics using Teams-Games-Tournaments Cooperative Learning Strategy as part of the teacher education syllabus during the training of mathematics teachers.

(iii) Teams-Games-Tournaments Cooperative Learning Strategy should be incorporated during in-service training of teachers organized by the Ministry of Education such as SMASSE. This would improve the quality of teaching for higher achievement especially in mathematics.

5.6 Suggestions for Further Research

This study suggests that the Teams-Games-Tournaments Cooperative Learning Strategy can improve mathematics teaching in secondary schools. Based on the research findings, the researcher identified the following areas that require further investigation:

(i) A study on other cooperative learning strategies and their effects on mathematics achievement, self-concept and perception of mathematics classroom learning environment should be carried out.

(ii) A comparative study should be conducted on the students' attitudes towards teaching using Teams-Games-Tournaments Cooperative Learning Strategy versus when taught using conventional teaching methods.

(iii) Research on the topics that can be effectively taught using Teams-Games-Tournaments Cooperative Learning Strategy should be identified from secondary school mathematics curriculum.

REFERENCES

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.

Adeniji, J. T. (1998). *WAEC Activities*. A report presented at the STAN Governing Council Meeting, International Conference Centre, Abuja, March 30-31.

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.

Anderson, L. W. & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching and Assessing*. Abridged Edition, Boston, MA: Allyn and Bacon.

Anderson, S., Yilmaz, O. & Wasburn-Moses, L. (2004). *Middle and High School Students with Disabilities: Practical Academic Interventions for General Education Teachers*. A review of the literature. American Secondary Education, 32, 19-38. September 27, 2005.

Aronson, E. (2000). *Nobody Left to Hate Developing the Emphatic Schoolroom*. *The Humanist*, 60, 17-21. Beverly Hills, CA: Sage Publications

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, 3*(1)*,* 7-12.

Baxendell, B. W. (2003). *Consistent, Coherent Creative: The 3 C's of Graphic Organizers. Teaching Exceptional Children*, 35(3), 46-53. Retrieved September 27, 2005, from Wilson Web database.

Borg, W. R. & Gall, M. D. (1989). *Education Research. An introduction* (5thed). White Plains, NY: Longman.

Borowski, E. J. & Borwein, J. M. (1991). *Harper Collins Dictionary of Mathematics*, Cellasgow: Colleens.

Bransford, J. D. (2004). *Schemata Activation and Schemata Acquisition. Theoretical Models and Processes of Reading* (5th ed.) pp 607- 619. Newark, DE: International Reading Association, Inc.

Braswell, J., Daane M. & Grigg, W. (2004). *The Nation's Report Card. Mathematics Highlights 2003.* U.S. Department of Education, Washington DC: National Center for Education Statistics.

Bruner, J. S. (1990). *Acts of Learning*. Cambridge, Mass: Harvard University Press.

Bryan, A. (2012). *Social Research Methods*. (4thed). New York.Oxford University Press.

Byrne, B. M. (1984)." *The General/Academic Self-Concept Nomological Network: A Review of Construct Validation Research."* Review of Educational Research, vol. 54(3), pp 427-456. http://rer.aera,net. Retrieved on March 5, 2016

Caverly, D. (1997). *Teaching Reading in a Learning Assistance Center*. In S. Mioduski & G. Enright (Eds.), Proceedings of the 17th and 18th annual institutes for learning assistance professional (pp 27-42).

Chambers, B. & Abrami, P. (1991). The Relationship between Student Team Learning Outcomes and Achievement, Causal Attributions, and Affect. *Journal of Educational Psychology, vol* 83(1), pp 140 - 146.

Changeiywo, J. M. (2001). Gender Perspectives in Science and Technology in Kenya. *Journal of Education and Human Resources, 1*(1)14-28.

Clements, D. H & Battista, M. T. (2012). *Constructivist Learning and Teaching*. Cambridge, Massachusetts. TERC.

Clements, D. H. & Sarama, J. (2009). *Learning and Teaching Early Math: The Learning Trajectories Approach.* New York. Routledge.

Conway, P. F. & Sloane, F. C. (2005). *International Trends in Post-Primary Mathematics Education.* Research Report Commissioned by the National Council for Curriculum and Assessment. Dublin, National Science Foundation.

Craven, J. A. & Penick, J. (2001). Preparing New Teachers to Teach Science: The Role of the Science Teacher Educator. *Electronic Journal of Science Education*, *13*(1) 1-30.

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.

David & Roger J. (2001). *An Overview of Cooperative Learning*. http://www.clcrc.com/pages /overviewpaper.html.

Dembo, M. H. (1994). *Applying Educational Psychology* (5thed). White Plains, NY. Longman Publishing Company.

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.

Dictionary, Encyclopedia & Thesaurus (Jan 20, 2012). *The Free Dictionary*. www.the freedictionary.com

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.

Earnest, P. (2004). *Images of Mathematics, Values and Gender: A Philosophical Perspective*. In B. Allen and S. Johnston-Wilder (Eds). Mathematics Education: Exploring the Culture of Learning. London: Routledge.

Effandi, Z. (2005). *Asas Pembelajaran Koperatif Dalam Matematik*. Shah Alam: Karisma Publications Sdn Bhd.

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

Felder, R. M. (1997). E-mail communication from felder@eos.ncsu.edu www page *http://www.ncsu.edu/unity/lockers/users/f/felder/public/rmf.html.*

Fraenkel, J. R. & Wallen, N. E. (2000). *How to Design and Evaluate Research in Education*. New York: McGraw-Hill High Education.

Gall, M. D., Gall, J. P. & Borg, W. R. (2007). *Education Research: An Introduction* (8thed.) Boston: Allyn and Bacon.

Garbett, D (2011). Developing Pedagogical Practices to Enhance Confidence and Competences in Science Teacher Education. *Journal of Science Teacher Education*, *22*(8), 729-743.

Gilbbon, B. S. & Herman, J. (1997). *True and Quasi-Experimental Design's, Learning House on Assessment and Evaluation,* Washington, D. Eric.

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

Government of Kenya (2007*). Kenya Vision 2030,* Nairobi: Government Printers.

Hamachek, D. (1995). *Psychology in Teaching, Learning and Growth*. (5thed). Boston, USA Allyn and Bacon.

Hington, P. R., Brownlow, C., McMurray, I., & Cozens, B. (2004). SPSS Explained. New York, NY: Routledge.

Johnson, D. W. & Johnson, R. T. (1984). *Circles of Learning*. Washington, DC: Assoc. Supervision and Curriculum Development.

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

Johnson, D. W., Johnson, R. T. & Smith, K. A. (1998). "*Cooperative Learning: Increasing College Faculty Instructional Productivity,*" ASHE-ERIC Higher Education Report 4. Washington D. C [Online]. Available from http://www.ntlf.com/html/lib/bib/92-2dig.htm.

Johnson, D. W., Johnson, R. T. & Smith, K. A. (2006). *Active Learning: Cooperation in the College Classroom.* Interaction Book Company, Edina, MN.

Jonassen, D. H. (1994). Thinking Technology. Toward a constructivist design model. *Journal of Educational Technology, 34*(4), 34-37.

Jonassen, D. H. (1999*). Constructing Learning Environments on the web: Engaging Students in Meaningful Learning*. EdTech: Educational Technology Conference and Exhibition 1999: Thinking Schools, Learning Nation.

Joyce, B.,Weil, M. & Calhoun, E. (2003). *Models of Teaching*, 6th edition, Allyn & Bacon,

Kanja, C., Iwasaki, H., Baba, T. & Ueda, A. (2001). Reform of Mathematics Education in Kenyan Secondary Schools. *Journal of International Development and Cooperation, 7*(1), 67-75.

Ke, F. & Grabowski, B. (2007). Game Playing for Maths Learning: cooperative or not? *British Journal of Educational Technology*, *38*(2), 249-259.

Kenya Institute of Education, (2002). *The Secondary School Syllabus vol, 2.*Nairobi.KIE.

Kenya Literature Bureau (2003). *Secondary Mathematics*. Students Book Two.3rd Edition, Nairobi. Kenya Literature Bureau.

Kiboss, J. K. (1997). *Relative Effects of a Computer-Based Instruction in Physics on Students' Attitudes, Motivation and Understanding about Measurement and Perception of Classroom Environment.* University of Western Cape: Unpublished Doctoral thesis.

Kibui, P. W & Macrae, M. F (2003). *Explore Mathematics Form 2.* Nairobi. Longman Publishers.

Kilpatrick, J., Swafford, J. & Findell, B. (2001). *Adding it up: Helping Children Learn Mathematics.* Washington DC: National Academy Press.

Kirembu, J. K. (1991). A Study of *Selected Teacher Factors Related to Performance in Mathematics Among Form Three Students in Kirinyaga District, Kenya.* Kenyatta University. Unpublished M.Ed. Thesis.

Kiruhi, M., Githua, B. & Mboroki, G. (2009). *Methods of Instruction*. Ongata Rongai: Gugno Books and Allied.

Kleinbaum, D.J. & Kupper, L.L. (1998). *Applied Regression Analysis and other Multivariate Methods.* Massachusetts. Duxbury

Koohang, A., Riley, L., Smith, T. & Schreurs, J. (2009). E-Learning and Constructivism: From Theory to Application. *Interdisciplinary Journal of E-learning and Learning Objects, 5*(1), 93- 95.

KNEC (2009). *The Year 2008 KCSE Examination Report.* Nairobi: KNEC.

KNEC (2010). *The Year 2009 KCSE Examination Report*. Nairobi: KNEC.

KNEC (2011). *The Year 2010 KCSE Examination Report*. Nairobi: KNEC.

KNEC (2012). *The Year 2011 KCSE Examination Report*. Nairobi: KNEC.

KNEC (2013). *The Year 2012 KCSE Examination Report.* With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

KNEC (2014). *The Year 2013 KCSE Examination Report*. With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

KNEC (2015).*The Year 2014 KCSE Examination Report.* With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

KNEC (2016). *The Year 2015 KCSE Examination Report*. With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

KNEC (2017). The Year 2016 KCSE Examination Report. With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

KNEC (2018). The Year 2017 KCSE Examination Report. With Question Papers and Marking Schemes. Volume 2: Mathematics and Science. Nairobi: KNEC.

Lawrence, I. A. & Kolawole, O. U. (2007). *Mathematics Education for Dynamic Economy in Nigeria in the 21st Century.* Nsukka, Nigeria.

Majda, S. & Branka, C. (2010). "Self –Concept of Student in Inclusive Setting" *International Journal of Special Education* 23(1), 340-362

Manion, L. & Morrison, K. (2007). *Research Methods in Education* (6thed.). London and New York: Routledge Falmer.

Marsh, H. W. (1990). Self–Description Questionnaire (SDQ) II: *A Theoretical and Empirical basis for the measurement of multiple dimensions of adolescent self-concept: An interim test manual and a research monograph* (p.5). San Antonio, TX: The Psychological Corporation.

Marsh, H. W. (1993). *Academic Self-concept: Theory, Measurement and Research*. In J. Suls(Ed), Psychological Perspective on Self (Vol.4, pp 59-98). Hillsdale, NJ: Erlbaum.

Marsh, H. W. (1996). ”Structures of artistic self-concept for performing arts and non-performing arts students in a performing arts high school: ’setting the stage’ with multi-group confirmatory factor analysis. ” *Journal of Educational Psychology*, *88*(3), 461-477.

Mayer, R. (2003). *Learning and Instruction*. New Jersey: Pearson Education, Inc.

Mbugua, Z, K., Kibet, K., Muthaa, G. M. & Nkonke, G. R. (2012). Factors Contributing to Students’ Poor Performance in Mathematics at Kenya Certificate of Secondary Education: A Case of Baringo County, Kenya. *American International Journal of Contemporary Research, 2*(6), 87-91.

McCracken, P. (2005). *Cooperative Learning as a Classroom Management Strategy*. Momentum, 36, 10-12. Retrieved from http://search.proquest.com/docview/194687714?accountid=1808

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, 26*(2), 253-266.

Mondoh, H. O. (2005). *Methods of Teaching Mathematics*. Njoro: Egerton University Press.

Mugenda, O. M. & Mugenda, A. G. (2003). *Research Methods; Quantitative and Qualitative Approaches.* Nairobi: African Center for Technology Studies (ACTS).

Mugo, K., Maina, L. & Ondera, J. (2003). *Advancing in Mathematics, Form 2*. Nairobi. Longhorn Publishers (K) Ltd.

Mundia, L. (2010). Problems in Learning Mathematics Comparison of Brunei Junior High School Students in Classes with and Without Repeaters: *Journal of Mathematics Research, 2*(3), 150-160.

Rajoo, M. (2013). Students’ perceptions of Mathematics classroom environment and Mathematics achievement: A study in Spitang, Sabah, Malaysia. Paper presented at the International Conference on Social Science Research, Penang, Malaysia, 4-5 June.

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.

Mutunga, P. & Breakel, J. (1992). *Mathematics Education*. Nairobi: ERAP

Muturi, C. (2003). *Solving Problems. KCSE Mathematics*. 2nd edition. Nairobi. Longhorn Publishers.

Nawaz, Q; Malik A. A. & Khan, F (2015). Effect of Cooperative Learning on the Self-Concept of High and Low Achiever Students at Elementary Level. *Gomal University Journal of Research, 31*(1), 41-52.

Nyeri Central Sub-County Office, (2016). KCSE 2010, 2011, 2012, 2013, 2014 & 2015 Results Analysis. Nyeri Central Sub-County.

OECD (2016). Programme for International Students Assessment (PISA) 2015 *Results in Focus*: Retrieved April 20th, 2017 *https://www.oecd.org/pisa/pisa-2015-results in focus.*

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* Vol.3, No.8, pp.57-61, Published by European Centre for Research Training and Development UK (www.eajournals.org)

Ormrod, J. E. (1995). *Education Psychology: Principles and Applications*. Englewood Cliffs, NJ: Prentice-Hall.

Ornstein, A. C. (1995). *Strategies for Effective Teaching*. (2nded.) Chicago, Brown & Benchmark Publishers.

Paik, S. J. (2003). *Ten strategies that improve learning. Educational Horizons*, 81, 83-5. Retrieved October 30, 2005, from Wilson Web database.

Pajeres, F. (2002). Overview of Social Cognitive Theory and of Self- Efficacy. [online] available: *http://www.emory.edu/education/mfp/eff.html.*

Pastorino, E. E. & Doyle-Portillo, S. M. (2013). *What is Psychology? Essentials*. Belmont, CA: Wadsworth.

Piaget, J. (1972). *Psychology and Epistemology: Towards a Theory of Knowledge*. Harmondsworth: Penguin.

Protheroe, N. (2007). What Does Good Math Instruction Look Like?, *Principal 7*(1),51- 54.

Remillard, H.A. (2015). The Effect of Cooperative Learning on Middle School Math Students. Wasshington D C. Heritage University.

Richardson, V. (2003). Constructivist Pedagogy. *Teacher College Record*, *105*(9), 1623-1640. https://doi.org10.1046/j.1467-9620.2003.00303.x

Salam, A. I, 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, 3*(3), 23-25.

Scopes, P. G. (1973). *Mathematics in secondary schools,* London. Cambridge University press.

Shama, R. N. (2002). *Methodology of Educational Research*. Delhi: Subject Publications.

Sharan, S. (2006). *Group Investigation and Student Learning: An Experiment in Singapore Schools.* Marshall Cavendish Academic.

Shellard, E., & Moyer, P. S. (2002). *What Principals Need to Know about Teaching Math* Alexandria, VA: National Association of Elementary School Principals and Education Research Service.

Shihusa, H. & Keraro, F. N. (2009). Using Advance Organizers to Enhance Students' Motivation in Learning of Biology. *Eurasia Journal of Mathematics, Science and Technology Education.*5(4), 413-420.

Sincero, S. M. (2012). Self- Concept Theory. Retrieved Jun 20, 2013 from Explorable.com: *http://explorable.com/self-concept-theory*

SMASSE (2000**)**. *Mathematics Teaching Methods*. Nairobi. SMASSE.

Steffe, L. P. & Gale, J. (1995*). Constructivism in Education.* Hillsdale, NJ: Lawrence Erlbaum, Oxford University Press.

Slavin, R. E. (1994). Student Teams Achievement Divisions. *Journal of Research and Development in Education, 12*(1), 39-49.

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

Slavin, R. E. (1995). Cooperative Learning. Needham Heights, MA: Simon & Schuster.

Slavin, R. E. (2011). Instruction Based on cooperative Learning. New York; NY: Plenum.

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.

Taber, K. S. (2006). Beyond Constructivism: The Progressive Research Programme into Learning Science. *Studies in Science Education*, *42*(1), 125-184.

Tavakol, M. & Dennic, R. (2011). Making Sense of Cronbach's Alpha. *International Journal of Medical Education, 2*(1), 53-55

The Education Alliance (2006). *Closing the Achievement Gap: Best Practices in Teaching Mathematics.* Charleston, WV: The Education Alliance.

Thirteen Ed Online (2004). Constructivism as a Paradigm for Teaching and Learning. *http://www.thirteen.org/edonline/concept2class/constructivism/index.html*

Trautwein, U., Ludtke, O., Nagy, G. & Marsh, H. W. (2009). Within School Social Comparisons: How students perceive the standing of their class predicts academic self-concept. *Journal of Educational Psychology*, *101*(4).853-866.

Daluba, N.E. (2013). Effect of Demonstration Method of Teaching on Students' Achievement in Agricultural Science. *World Journal of Education, 3*(6), 1-7.

VonGlaserfeld, E. (1991). *Radical Constructivism in Mathematics Education* (xiii-xx). Dordrecht. The Netherlands: Kluwer.

Vygotsky, L. S. (1978). *Mind in Society*. Cambridge, MA: Harvard University Press.

Weiten, W., Dunn, D. S. & Hammer, E. Y. (2012). *Psychology Applied to Modern Life: Adjustments in the 21st Century.* Belmont, CA: Wadsworth.

Woodhouse, H (2012). *Mathematics as Liberal Education: Whitehead and the Rhythm of Life.* A paper presented to the Center of Logic and Philosophy of Science, Free University of Brussels (VUB) on 16th May 2012.

APPENDICES

Appendix 1: Training Manual on TGT Cooperative Learning Strategy

Purpose of the Manual

The purpose of this manual was to assist mathematics teachers involved in this study to plan and implement the TGT Cooperative Learning Strategy in the topic 'Similarity and Enlargement' taught to Form Two students. The TGT Cooperative Learning Strategy improves learners' participation for meaningful learning.

Aim of the Manual

The aim of this manual is to minimize variability among the teachers as they teach the topic similarity and enlargement using TGT Cooperative Learning Strategy. TGT Cooperative Learning Strategy is based on student's active participation with emphasis on problem-solving and high-order thinking skills regarding a learning activity that they find relevant and engaging. It involves knowledge construction with exploration in order to encourage students to seek knowledge rather than reproduction. Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks. Teams Games Tournament (TGT) is a cooperative learning strategy that enhances students' academic achievement and attitudes towards the content material. TGT has three basic elements:

(1) Teams— students are assigned to equal teams categorized by mixed academic levels,
(2) Games —skill exercises relating to content material are played during tournaments,
(3) Tournaments —students represent their teams and compete individually against students from other teams.

Teachers serve in the role of guides, monitors, coaches, tutors and facilitators.

Instructional Objectives

Instructional objectives are the end results in the lesson as stated in terms of changes of learner's behavior. Behavior includes mental (cognitive), emotional (affective) and physical (psychomotor) domains. Instructional objectives should be stated in terms of learning outcomes because the major concern is the products of learning rather than the process of learning.

Importance of Instructional Objectives

Instructional objectives guide the teacher in organizing the learning experiences, selection of learning resources and the content to be covered in an instructional session. They are also used as a basis of assessment of learners at the end of the lesson, school term or school year. Instructional objectives will assist the learner in self-evaluation of his/her performance in a given subject and also planning for individual coverage of content. Teachers will use instructional objectives to select the teaching strategies and methods to enhance learning.

Classification of Instructional Objectives

Instructional objectives are classified into cognitive, affective and psychomotor domains.

Cognitive Domain

Objectives in the cognitive domain are concerned with knowledge outcomes which involve intellectual abilities and skills. These objectives can be grouped into six major classes:

(i) Remembering- the objectives involve the recognizing or recalling previously learned facts, terms concepts and answers. Learners are required to define, find, name, list, label, choose, match, spell, etc.

(ii) Understanding-the objectives measure the understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions and stating main ideas. Learners are required to explain, classify, demonstrate, compare, contrast, interpret, illustrate, infer, relate, etc.

(iii) Applying- the objectives involve solving problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way. Action verbs include apply, choose, construct, identify, organize, plan, select, solve, etc.

(iv) Analyzing- these objectives involve examining and breaking information into parts by identifying motives or causes, making inferences and finding evidence to support generalizations. Learners are required to analyze, assume categorize, classify, compare, contrast, distinguish, examine, etc.

(v) Evaluating- learners are required to present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria. Learners will appraise, assess, choose, compare, conclude, criticize, deduct, determine, etc.

(vi) Creating- these objectives will involve compiling information together in a different way by combining elements in a new pattern or proposing alternative solutions. Learners will adapt, build, change, choose, compose, construct, design, develop, discuss, etc.

Affective Domain

These are learning outcomes which relate to attitudes, interests, feelings, believe and values. These objectives are classified into five categories:

(i) Receiving- this is the willingness of the learner to attend to particular phenomena or stimuli. The objectives use verbs such as select, give, identify, name, locate, etc.

(ii) Responding- This refers to active participation on the part of the student. The objectives are stated using the verbs such as conform, perform, recite, tell, write, report, etc.

(iii) Valuing- this refers to the value or worth a learner attaches to a particular object. Action verbs for stating the objectives include: demonstrate, differentiate, form, justify, etc.

(iv) Organization- this involves bringing together different values, resolving conflicts between them and building of an internal consistent value system. The objectives use words such as alter, arrange, relate, order, modify, defend, explain, etc.

(v) Characterization by value- the individual has a value that guides development of a characteristic lifestyle. Words such as act, display, discriminate, listen, verify, qualify and propose are used in the objectives.

Psychomotor Domain

This involves physical movement, coordination and use of motor skills. The skills require speed, procedures, techniques and precision. They are grouped into seven classes:

(i) Perception- this is concerned with the use of sense organs. Action verbs in these objectives include choose, detect, distinguish, isolate and select.

(ii) Set- this refers to the readiness to take a particular type of action. Action verbs in the objectives include begin, proceed, react and show.

(iii) Guided response- this is concerned with the early stages of learning a complex skill. The objectives use such words as copy, follow, reproduce, respond and trace.

(iv) Mechanism- this is concerned with performance where the learned responses have become habitual and the movements can be performed with some confidence and proficiency. Action verbs include assemble, fix, heat, construct and display.

(v) Complex overt response- this involves skillful performance of motor acts with speed, accuracy and high coordination. Action verbs include assemble, fix, heat, construct, display, dismantle, etc.

(vi) Adaptation- skills are well developed that the individual can modify movement patterns to fit special requirements. Action verbs include adapt, alter, change, rearrange, revise, vary, etc.

(vii) Origination- this involves creating new movements to fit a particular situation or specific problem Action verbs include originate, create, design, initiate combine and compose.

Instructional Objectives for the Topic 'Similarity and Enlargement'

By the end of the topic the learner should be able to;

(i) Identify similar figures

(ii) Construct similar figures

(iii) State properties of enlargement as a transformation

(iv) Apply properties of enlargement to construct objects and images

(v) Apply enlargement in Cartesian planes

(vi) State the relationship between linear, area and volume scale factors

(vii) Apply the scale factors to real life situations**.**

Content of the topic 'Similarity and Enlargement'

The content includes:

(i) Similar figures and their properties

(ii) Construction of similar figures

(iii) Properties of enlargement

(iv) Construction of objects and images under enlargement

(v) Enlargement in the Cartesian plane

(vi) Linear, area and volume scale factors.

(vii) Real life situations involving similarity and enlargement.

The content is to be covered in 19 lessons each of 40 minutes. For the purpose of this study it will take 24 lessons (4 weeks) because of the implementation of TGTCLS and assessment.

Suggested Teaching / Learning Resources

These include geometrical instruments, models, maps, photographs, maps, charts illustrating similarity and enlargement

TGT Cooperative Learning Strategy

Presentations

The teacher initially introduces the material in a class presentation. In most cases, this is a lecture/discussion, but it can include an audiovisual presentation. Class presentations in TGT differ from usual teaching only in that they must clearly focus on the TGT unit. Thus, students realize that they must pay careful attention during the presentation, because doing so will help them to do well on the quizzes, and their quiz scores determine their team scores.

Teams

Teams are composed of four or five students who represent a cross-section of the class in academic performance, sex, and race or ethnicity. The major function of the team is to prepare its members to do well on the quizzes. After the teacher presents the material, the team meets to study worksheets or other material. The worksheets are teacher-made. Most often, the study takes the form of students quizzing one another to be sure that they understand the content, or working problems together and correcting any misconceptions if teammates make mistakes. The team is the most important feature of TGT. At every point, the emphasis is on the members doing their best for the team, and on the team doing its best for its members. The team provides the peer support for academic performance that is important for learning.

Games

The games are composed of simple, course content-relevant questions that students must answer, and are designed to test the knowledge gained by students from class presentations and practice.

Tournaments

The tournament is the structure in which the games take place. It is usually held at the end of the week, after the teacher has made class presentation and the teams have had time to practice with the worksheets. It will take forty minutes which is equivalent to one class period. The purpose is for the students to compete and earn points for their respective teams.

In TGTCLS, tournaments are held on weekly basis. Based on students' previous performance, academically similar students are assigned to each tournament table. Once the games are completed, students are ranked and given points that they take back to their teams. The sum of the team points, to which each team member has contributed, determines the team which wins the tournament, thus maintaining "reward interdependence" within each practice team. Students compete at tournaments table against students from other teams who are equal to them in terms of past performance. Students earn team points based on how well they do at their tournament tables. In this study, tournaments will be held fortnightly to allow adequate coverage of the content in the topic Similarity and Enlargement.

Teams-Games-Tournaments Instructions

Step 1: Divide the class into teams of five. A class of 45 students would have 9 teams while a class of 40 would have 8 teams of 5.

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

Step 3: Display the answers on the overhead projector or blackboard and get each team to check their answers and resolve any issues with their answers.

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

Step 5: Regroup all the A students in one area of the room, B students in another area etc.

Step 6: Give the test version questions to each student and instruct them to individually answer the questions under formal test conditions.

Step 7: Display a copy of the answers on the overhead projector or blackboard and get each student to mark their answers and then rank themselves amongst the group of students they are grouped with. That is, A students will rank themselves from best to worst score. The student with the best score is given a score of 9 and 8 points in a class of 9 and 8 teams respectively. The student with the lowest score is given a score of 1 point.

Step 8: The students recombine into their original teams and total their scores. The team with the highest score wins.

Appendix 2: Teaching Module Using TGT Cooperative Learning Strategy

WEEK 1

Lesson 1

Objectives of the Lesson

By the end of the lesson the learner should be able to

a) Identify similar figures
b) Construct similar figures

Learning Activities

Learners are likely to misinterpret the concept of similar figures and similar solids to mean those that are of equal lengths of the sides.

To eliminate the misconception, the learners will be engaged in several activities to help them understand the concept of similarity.

Activity 1

i) Construct rectangle ABCD such that AB=5cm and BC=2cm.

ii) Construct another rectangle EFGH such that EF=10cm and FG=4cm.

iii) Work out the ratios of the corresponding sides

AB: EF=1:2 and BC: FG=1:2. The ratios are equal

iv) Teacher guides the learners to deduce that the corresponding angles in the two rectangles are equal and the ratios of corresponding sides are equal hence the two rectangles are said to be similar.

Activity 2

Teacher provides charts of figures with different lengths of sides and angles. Learners are asked to identify those figures that are similar.

Teacher presents models of cubes, cuboids and cylinders of different lengths and asks the learners to identify the similar solids.

Teacher asks the learners the relationship between the corresponding angles and sides. Students will discover that the corresponding angles are equal and the ratio of the corresponding sides is constant.

Conclusion: Two figures are similar if their corresponding angles are equal and the ratio of the corresponding sides is constant.

Lesson 2

By the end of the lesson the learner should be able to

a) Identify similar figures

b) Construct similar figures

Activity

(i) Construct triangle ABC that AB=2cm, BC=3cm and AC=4cm. Measure the three angles of the triangle.

(ii) Construct triangle XYZ such that XY=4cm, YZ=6cm and XZ=8cm. Measure the three angles of the triangle.

Determine whether the two triangles are similar

(iii) Construct two triangles with corresponding angles equal to 60^0, 50^0, and 70^0 with sides of different lengths. Find the ratio of the corresponding sides and determine whether they are similar.

(iv) Construct rectangle ABCD with AB=3cm and BC=4cm. Construct another rectangle KLMN with KL=6cm and LM=9cm. Determine whether or not the two rectangles are similar.

Lesson 3

Objective of the Lesson

By the end of the lesson, the learner should be able to apply properties of similarity to determine lengths of sides of similar figures

Examples

Teacher guides the students to work out the following in class

(i) Rectangle ABCD is similar to rectangle WXYZ.AB=4cm and WX=5cm.If BC=9cm, Calculate the length of XY.

(ii) A matchbox is in the shape of a cuboid 6cm long, 3cm wide and 2cm high. Matchboxes are packed in similar box, which is 45cm wide. Calculate the length and height of the box

(iii) A water tank is in the shape of a cylinder radius 2cm and height 3cm.A similar tank has radius 1.5m. Calculate height of the smaller tank

(iv) Milk powder is sold in similar cylindrical tins. The small tins are 20 cm high 10cm in diameter. If the radius of large tin is 7.7cm, calculate its height.

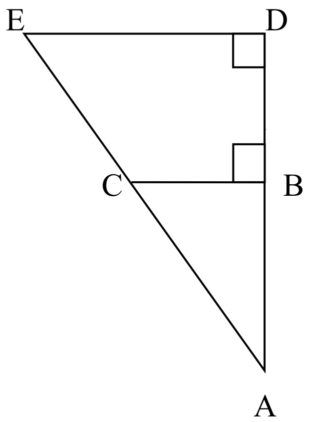
Lesson 4

Objective of the Lesson

By the end of the lesson, the learner should be able to apply properties of similarity to determine lengths of sides of similar figures

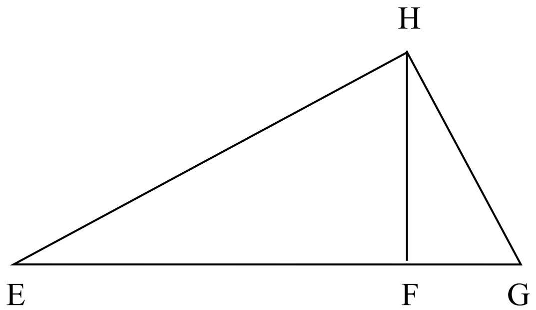
Examples

(1) In the figure below AB=8cm, BC=6cm and AD=12cm.



Identify the two similar triangles and hence calculate the length of DE and CE.

(2) In the figure below <EHG=<EFH=90^0.HF=5cm and EF=12cm.



Identify the two similar triangles hence calculate the height HG and FG.

Lesson 5

Objective of the Lesson

The learner should be able to state and apply properties of enlargement as a transformation.

Learning Activities

Learners are asked to define the term ‘enlargement’ from previous experience. Learners are asked to identify the figures on the chart that are as a result of enlargement. They are also asked to identify the solids that are as a result enlargement.

Learners are likely to interpret enlargement for as long as there is increase in size and hence are likely to confuse the terms ‘similarity’ and ‘enlargement’.

To eliminate the misconception, learners will be involved in some activities in class

Students do the following in class

(i)Draw any triangle XYZ and choose a point O outside the triangle

(ii)Draw construction lines OX, OY and OZ and produce them.

(iii)Measure OX, OY and OZ

(iv)Mark the points X', Y', and Z' on OX, OY and OZ produced such that OX'=2OX, OY'=2OY and OZ'=2OZ.

(v) Join X', Y' and Z' to obtain the triangle the triangle X'Y'Z'.

(vi)Teacher guides the learners to notice that

(a) the corresponding angles of the two triangles are equals

(b) the ratio of lengths of corresponding sides is 2

(vii)Teacher defines the following

(a) O is called the centre of enlargement

(b) 2 is called the linear scale factor

Hence an enlargement is fully described by the centre and scale factor of enlargement.

Examples

(i) Construct any triangle ABC. Take a point O outside the triangle with O as the centre of enlargement and scale factor 3, construct the image ABC under the enlargement.

(ii) Construct a rectangle with length 4cm and width 3cm and diagonals intersect at O. Using O as the centre of enlargement and scale factor 2, draw its image.

Lesson 6

Objectives of the Lesson

The learner should be able to

(a) State and apply properties of enlargement as a transformation.

(b) Apply the enlargement in Cartesian planes.

Examples

Teacher guides the students to do the following questions.

(i) Plot the points A (3, 4), B (4, 4) and C (6, 4) on a square grid. With centre (0, 0) and enlargement scale factor 2, locate the image A'B'C'.

(ii) A triangle with vertices P (3, 0), Q (5, 1) and R (4, 4) is enlarged with centre (1, 0) and scale factor 3. Draw the object and the image on a square grid.

(iii) A triangle with vertices A (-1,1), B(-1,3) and C(-2,2) is enlarged with centre (-1,0) and scale factor 2. Determine the co-ordinates of its image.

WEEK 2

Lesson 1

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images

(b) Apply enlargement in Cartesian planes

Learning Activities

Students to do the following activities

(i) Draw any triangle XYZ and choose a point O outside the triangle

(ii) Construct lines OX, OY and OZ

(iii) Measure OX, OY and OZ

(iv) Mark the points X', Y' and Z' such that OX'= ½OX, OY'= ½OY and OZ'= ½OZ.

(v) Join the points X', Y' and Z' to obtain the image X'Y'Z'

The centre of the enlargement is the point O with scale factor ½.

Teacher guides the students to know that the image is smaller than the object which is actually a diminution.

Example

A triangle ABC has vertices A (0,3), B(3,3) and C(3,6). Construct the triangle ABC and its image ABC under enlargement scale factor $\frac{1}{3}$ and centre the origin.

Lesson 2

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images

(b) Apply enlargement in Cartesian planes

Teaching/ Learning Activities

Teacher guides the students to solve the following questions

(i) Given that P(3,4), Q(4,4),R(6,4),S(7,1) and T(5,0) are vertices of a pentagon PQRST. Find the vertices of the image after an enlargement with the centre at (0, 0) and scale factor ½.

(ii) On a square grid draw a quadrilateral with vertices A (0,3), B(2,3), C(3, 1) and D (3,-2). With the centre (2, 1) and scale factor $\frac{1}{3}$, draw the image A'B'C'D'.

Lesson 3

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images

(b) Apply enlargement in Cartesian planes

Teaching/ Learning Activities

(i) Draw triangle ABC and choose a point O outside the triangle

(ii) Draw construction lines OA, OB and OC and produce them on the opposite side of O

(iii) Measure OA, OB and OC.

(iv) On the opposite side of the object ABC, mark A', B' and C' such that OA'=2OA, OB'=2OB and OC'=2OC

(v) Join A', B' and C' to obtain the image A'B'C'

(vi) Students should note that

(a)The object ABC and the image A'B'C' are on the opposite sides of the centre of enlargement.

(b)The image is inverted

(c)The object has been enlarged by scale factor 2.

(d)Any line in the image is parallel to the corresponding line on the object.

Conclusion: The triangle A'B'C' is the image after enlargement scale factor -2 and centre O.

Examples

(i) On the square paper, draw the quadrilateral with vertices A (4, 2), B (9, 2), C(7,-2) and D(2,-2) Draw the image A'B'C'D' under enlargement scale factor -2 and centre the origin.

(ii) A triangle with vertices P (3, 0), Q (5, 1) and R (4, 4) is enlarged with centre (1, 0) and scale factor -3. Draw the object and the image on a square grid.

Lesson 4

Objective of the lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images.

(b) Apply enlargement in Cartesian planes.

(c) Determine the scale factor and centre of enlargement.

Teaching/Learning Activities

(i) On a squared grid students, draw triangle ABC with vertices A (5, -2), B (3,-4) and C (7,-4). On the same grid they draw the image triangle A' (5, -2), B' (7,-10) and C' (3,-10).

(ii) Students join AA', BB' and CC'. The lines are produced to obtain the centre and the scale factor of the enlargement.

Examples

(i) A' (1,4), B'(-1,2) and C'(2,2) are the vertices of the image of triangle ABC with vertices A(1,-2), B(-5,-4) and C(4,-4). On a square grid draw the two triangles and fully describe the transformation.

(ii) A triangle with vertices P (1,0), Q(2,1) and R(2,3) is mapped onto a triangle P'(-3,0), Q'(-6,-3) and R'(-6,-9) under an enlargement. Find the scale factor and the centre of enlargement.

Lesson 5

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) apply properties of enlargement to construct objects and images

(b) apply enlargement in Cartesian planes

Teams-Games-Tournaments Practice

Step 1: The teacher divides the class into teams of 5 students.

Step 2: The teacher then distributes the practice version of the test to each student and they answer the questions cooperatively as a team. The practice version will be composed of the following questions:

(i) A triangle with vertices A (6, 2), B (6, 4) and C (5, 4) is enlarged by scale factor 2 with centre (5, 0). Find the coordinates of the image.

(ii)The vertices of an object and its image after enlargement are A (-1,2), B (1,4), C (2,2) and A'(-1,-2),B'(5,4),C'(8,-2) respectively. Find the centre and the scale factor of the enlargement.

(iii) The vertices of the object and its image are P (6,6), Q (6,4), R (2,2) and P' (3,3), Q' (3,2), R'(1,1)respectively. Find the centre and scale factor of the enlargement.

(iv) The vertices of triangle ABC are A (2,1), B (2,3) and C (3,3). Find its image under an enlargement centre (1,0) and scale factor -3.

(v) Points A (-2,2) and B (-3,7) are mapped onto A' (4,-10) and B' (0,10) respectively by an enlargement. Find the

(a) scale factor and centre of enlargement.

(b) the image of C (-1,1) and D (-2,6) under the enlargement.

Step 3: Display the answers on the overhead projector or blackboard and get each team to check their answers and resolve any issues with their answers.

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

Lesson 6

Teams-Games-Tournaments Test

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) apply properties of enlargement to construct objects and images

(b) apply enlargement in Cartesian planes

Step 1: Regroup and seat all the A students in one area of the room, B students in another area etc.

Step 2: Give the test version questions to each student and instruct them to individually answer the questions under formal test conditions. The test version questions will include:

(i) A triangle with vertices A (5, 2), B (5, 4) & C (4, 4) is enlarged by scale factor 2 with centre (4, 0). Find the coordinates of the image.

(ii) The vertices of an object and its image after enlargement are A (-1,1), B (1,3), C (2,1) and A' (-3,3), B' (3,9), C' (6,3) respectively. Find the centre and the scale factor of enlargement

(iii) The vertices of the object and its image are P (6,6), Q (6,4), R (2,2) and P' (3,3), Q' (3,2), R' (1,1) respectively. Find the centre and scale factor of the enlargement.

(iv) The vertices of triangle ABC are A (2, 1), B (2,3) and C (3,3). Find its image under an enlargement centre (1, 0) and scale factor -3.

(v) The vertices of rectangle ABCD are A (3, -4), B (7,-4) and C (7,-2).The images A and B under an enlargement are A (7, 6) and B (3, 6). Find

(a) the coordinates of D

(b) the scale factor and enlargement centre of enlargement.

(c) the image of C and D.

Step 3: Display a copy of the answers on the overhead projector or blackboard and get each student to mark their answers and then rank themselves amongst the group of students they are grouped with. That is, A students will rank themselves from best to worst score. The student with the best score is given a score of 8 or 9 points while the student with the lowest score is given a score of 1 point.

Step 4: The students recombine into their original teams and total their scores with the team having the highest score winning.

WEEK 3

Lesson 1

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images

(b) Apply enlargement in the Cartesian planes

Learning Activities

(i) Draw a triangle ABC and choose a point O outside the triangle

(ii) Draw the construction lines OA, OB and OC and produce the opposite side from O

(iii) Measure OA, OB and OC.

(iv) Mark the point A', B' and C' on the opposite side of A, B and C of O such that OA' $= \frac{1}{2}$ OA, OB' $= \frac{1}{2}$ OB and OC'$= \frac{1}{2}$ OC

(v) Join A', B' and C' to obtain the image triangle A'B'C'.

(vi) Students should note that

(a) The object ABC and the image A'B'C' are on opposite sides of the centre of enlargement

(b) The image is inverted

(c) The image is smaller than the object i.e. reduced by ½

(d) Any line on the image is parallel to the corresponding line on the object

Conclusion: Triangle A'B'C' is the image under enlargement scale factor -½ and the centre O.

Example

Plot the points A (4, 2), B (9, 2) and C (7, -2).Taking the origin as the centre of enlargement. Construct the image when scale factor $-\frac{1}{4}$

Lesson 2

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) Apply properties of enlargement to construct objects and images

(b) Apply enlargement in the Cartesian planes

Examples

(i) On a graph paper draw a quadrilateral with vertices A (0, 3), B (2, 3), C (3, 1) and D (3, -2). Construct the image A'B'C'D' under the enlargement centre (-2, 5) and scale factor $-\frac{1}{4}$.

(ii) Points A (-2, -1), B (1, -1), C (1, -4) and D (-2, -4) are vertices of a square. Without drawing state the coordinates of the image of the square under enlargement with the centre the origin and scale factor $-\frac{1}{4}$.

(iii) A square has vertices A (1, 1), B (3, 1), C (3, 2) and D (1, 2). Find the image A'B'C'D' under enlargement scale factor -1.5 with centre A.

Lesson 3

Objective of the Lesson

By the end of the lesson, the learner should be able to state the relationship between the linear scale factor and area scale factor.

Learning Activities

(i) Construct a rectangle ABCD such that AB=3cm and BC=2cm.

(ii) Mark a point O outside the rectangle

(iii) Using O as the centre and 2 as the scale factor of enlargement, construct the image A'B'C'D'

(iv) Measure the length A 'B' and B'C'. Notice that A'B' = 6cm and B'C' = 4cm.

(v) Area of ABCD = 2x3 = $6cm^2$

Area of A'B'C'D' = 6x4 = $24cm^2$

$$\frac{\text{Area of A'B'C'D'}}{\text{Area of ABCD}} = \frac{24}{6}$$

$$= 4$$

(vi) Teacher guides the learners to define area scale factor as the ratio of area of image to area of object.

(vii) Teacher guides the learners to establish the relationship between area scale factor and linear scale factor.

From the above, L.S.F = 2 and A.S.F = 4

Therefore, A.S.F = $(L.S.F)^2$

Example

(i) Construct triangle with base 3 cm and height 4 cm.

(ii) Mark a point outside the triangle.

(iii) Enlarge the triangle with O as the centre and scale factor 3.

(iv) Find the area of image and object

Area of the object = $6cm^2$

Area of the object = $54cm^2$

Area scale factor = $\frac{54}{6} = 9$

But $9 = 3^2$

Hence A.S.F. = $(L.S.F.)^2$

Lesson 4

Objective of the Lesson

By the end of the lesson, the learner should be able to state the relationship between the linear scale factor and area scale factor.

Example

Construct triangle of base 4 cm and height 10cm.Mark a point O outside the triangle and construct the image of the triangle under enlargement centre O and scale factor

(i) $\frac{1}{2}$

(ii) $-\frac{1}{2}$

Find the area of the object and the image and hence determine the relationship between the LSF and ASF

Lesson 5

Objective of the Lesson

By the end of the lesson the learner should be able to apply linear and area scale factors to real life situations.

Learning Activities

Students work out the following in class individually under the supervision of the teacher.

(i) The ratio of the corresponding sides of the similar triangle is $^3/_2$. If the area of the smaller triangle is $6cm^2$, find the area of the larger triangle.

(ii) A plan of a house measures 20 cm by 13cm. Find the area of the actual house if the linear scale factor is 50.

(iii) A map of a certain town is drawn to a scale factor 1:50000. On the map the railway quarters cover an area of $10cm^2$.Find the area of the railway quarters in hectares.

(iv) The ratio of area of two circles is 16:25.

(a) What is the ratio of the radii?

(b) If the smaller circle has a diameter of 28cm, find the diameter of the larger circle.

Lesson 6

Objective of the Lesson

By the end of the lesson the learner should be able to apply linear and area scale factors to real life situations.

Learning Activities

Students work out the following in class individually under the supervision of the teacher.

(i) The corresponding sides of the two regular pentagons are 3cm and 7cm respectively

(a) Find the ratio of the areas

(b) Calculate the area of the larger one if the area of the smaller one is $36cm^2$.

(ii) The ratio of the area of the two smaller rooms is $^4/_{25}$.

(a) Find the area of the bigger room if the area of the smaller room is $8cm^2$.

(b) Find the ratio of the lengths.

(c) If the length of the bigger room is 10m; find the length of the smaller one.

(iii) A larger estate is represented by a rectangle 4mm long and 3mm wide on a map whose scale is 1: n. If the actual area of the estate is 108 hectares, determine the value of n.

WEEK 4

Lesson 1

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) State the relationship between linear scale factor and volume scale factor.

(b) Apply scale factors to real life situations.

Learning Activities

(i) Draw two similar cuboids. The big one measuring 2cm×3cm×5cm and the smaller one 1cm×1.5cm×2.5cm.

(ii) Determine the linear scale factor =2

(iii) Find the volume of each of the cuboids

Volume of smaller = $1\times1.5\times2.5 = 3.75cm^3$

Volume of bigger = $2\times3\times5 \quad = 30cm^3$

(iv) Find the ratio of the volumes (volume scale factor)

$= \frac{30}{3.75} = 8 = 2^3$

hence V.S.F = $(L.S.F)^3$

Example

Two similar cylinders have radii 3cm and 9cm respectively. If the larger cylinder has height 21cm, find

(i) the linear scale factor

(ii) the volumes of the cylinders

(iii) the volume scale factor

(iv) the relationship between the LSF and VSF

Lesson 2

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) State the relationship between linear scale factor and volume scale factor.

(b) Apply scale factors to real life situations.

Leaning Activities

Teacher guides the learners in working out the following questions in class

A cylinder with base radius 7cm and volume 77cm^3 is similar to another cylinder of radius 14cm.Find the volume of the second cylinder.

L.S.F $= \frac{7}{14} = \frac{1}{2}$

Volume scale factor = $(^1/_2)^3 = {^1/_8}$

Volume of the second cylinder = $8 \times 77 = 616$cm^3

Examples

(i) The corresponding length of the two similar blocks of wood measure 15cm and 30cm. If the smaller block has volume 50 cm^3, find volume of the bigger block.

(ii) Two similar cylindrical tanks have volume 125cm^3 and 216cm^3. If the bigger one has radius 30cm, find the radius of the smaller one.

(iii) Two similar jugs have capacities of two litres and ¼ litre. If the height of the larger jug is 30cm, find the height of the smaller one.

Lesson 3

Objectives of the Lesson

By the end of the lesson the learner should be able to:

(a) State the relationship between linear, area and volume scale factors.

(b) Apply scale factors to real life situations.

Teams-Games-Tournaments Practice

Step 1: The teacher divides the class into teams of 5 students.

Step 2: The teacher then distributes the practice version of the test to each student and they answer the questions cooperatively as a team. The practice version will be composed of the following questions:

(i) Three cones are of radii 14cm, 10.5cm and 7cm respectively. If the height of the first cone is 42cm, calculate

(a) the height of the other cones.

(b) the ratio of the curved surface areas of the first and third cone.

(c) the ratio of the volumes of the second and the third cone.

(ii) Two spheres have surface area of $36cm^2$ and $49cm^2$ respectively. If the volume of the smaller sphere is $20.2cm^3$, calculate volume of the larger one.

(iii) The depths of two similar buckets are 28cm and 21cm respectively. If the larger bucket holds 3.1 litres, find the capacity of the smaller one.

(iv) The ratio of the base areas of the two cones is 9:16.

(a) Find the ratio of their volumes

(b) If the larger one has a volume of $125cm^3$, find the volume of the smaller cone.

(v) Two similar cones made of the same wood have masses 4kg and 0.5kg respectively. If the base area of the smaller cone is $38.5cm^2$, find the area of the larger one.

(vi) The radius of a soap bubble increases by 4%. Calculate the percentage increase in its:

(a)Surface area

(b)Volume

Step 3: Display the answers on the overhead projector or blackboard and get each team to check their answers and resolve any issues with their answers.

Step 4**:** Ask the students to sort their team on the basis of their understanding of the topic from very good understanding (A students) to poor understanding (E students).

Lesson 4

Teams-Games-Tournaments Test

Objective of the Lesson

By the end of the lesson the learner should be able to apply scale factors to real life situations.

Step 1: Regroup all the A students in one area of the room, B students in another area, etc.

Step 2: Give the test version questions to each student and instruct them to individually answer the questions under formal test conditions. The test version questions will include:

(i) Three cones are of radii 7cm, 14cm and 10.5cm respectively. If the height of the first cone is 42cm, calculate

(a) the height of the other cones.

(b) the ratio of the curved surface areas of the first and third cone.

(c) the ratio of the volumes of the second and the third cone.

(ii) Two spheres have surface area of $64cm^2$ and $100cm^2$ respectively. If the volume of the smaller sphere is $25cm^3$, calculate volume of the larger one.

(iii) The depths of two similar buckets are 35cm and 14cm respectively. If the larger bucket holds 34.3 litres, find the capacity of the smaller one.

(iv) The ratio of the base areas of the two cones is 16:25. If the larger one has a volume of $500cm^3$, find the volume of the smaller cone.

(v) Two similar objects made of the same wood have masses 24kg and 81kg respectively. If the surface area of the larger one is $540cm^2$, find the surface area of the smaller one.

(vi) The radius of a soap bubble increases by 20%. Calculate the percentage increase in its:

(a) Surface area

(b) Volume

Step 3: Display a copy of the answers on the overhead projector or blackboard and get each student to mark their answers and then rank themselves amongst the group of students they are grouped with. That is, A students will rank themselves from best to worst score. The student with the best score is given a score of 9 and 8 points if in group E1 and E2 respectively while the student with the lowest score is given a score of 1 point.

Step 4: The students recombine into their original teams and total their scores with the largest score winning.

Appendix 3: Mathematics Achievement Test (MAT)

Form 2 Mathematics **Time: 1Hr**

School...Class...

Instructions

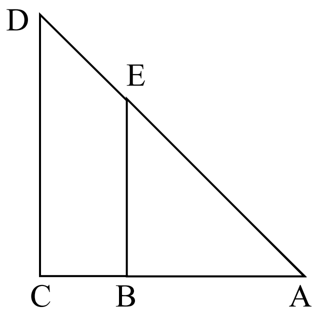
a) Answer **ALL** questions

b) Read the questions carefully to ensure that you understand before answering

Show all your working giving answers at each step

(1) A jewel box of length 30 cm is similar to a matchbox which is 5 cm long, 3.5cm wide and 1.5 cm high. Find the breadth and height of the jewel box. (3 marks)

(2) In the figure below triangle ABE is similar to triangle ACD. BE=4cm, DC=9 cm and AB= 6cm. Calculate the length of BC. (3 marks)



(3) On a map with a scale of 1:50000, a coffee plantation covers an area of 20cm^2. Find the area of plantation in hectares. (4 marks)

(4) A container of height 30 cm has a capacity of 1.5 litres. What is the height of a similar containerofcapacity3.0m^3? (4 marks)

(5) A football tube in the form of a sphere is inflated so that its radius increases in the ratio of 4:3. Find the ratio in which the volume is increased. (2 marks)

(6) The areas of the lids of two similar cylinders are 160cm^2 and 250cm^2. If the radius of the bigger cylinder is 80cm, find the radius of the smaller cylinder. (4 marks)

(7) Two cylindrical containers are similar. The larger one has an internal cross-sectional area of 45cm^2 and can hold 0.945litres of liquid when full. The smaller container has internal cross-sectional area of 20 cm^2; calculate the capacity of the smaller container. (4 marks)

(8) A prism has a volume of 72.96cm^3. A second prism is similar to the first one but made of a different material has volume 246.24cm^3. If the first prism has a cross-sectional area of 9.12cm^3, find the cross-sectional area of the second prism. (4 marks)

(9) The total surface area of a model of a cylindrical water tank is 0. 4cm^2.The total surface area of the actual tank is 14.4m^2.

(i) If the height of the tank is 2.1m, find the height of the model (3 marks)

(ii) If the capacity of the model is 23.15litres, find the capacity of the tank to the nearest litre. (3 marks)

(10) A square P (6, -2), Q (7, -2), R (7, -1) and S (6, -1).Draw the square PQRS and its image P'Q'R'S' under and an enlargement scale factor 3, centre (9, -4). (4 marks)

(11) A (0, 3), B (2, 3), C (3, 1) and D (3, -2) are the vertices of a quadrilateral. Draw the quadrilateral ABCD and its image under the enlargement centre (2, 1) and scale factor $\frac{1}{3}$. (4 marks)

(12) Given that A (-2, -1), B (1, -1) and C (1, -4) are vertices of a triangle. Draw the triangle ABC and its image under enlargement centre the origin and scale factor -2. (4 marks)

(13) ABCD is a square with vertices A (1, 1), B (2, 1), C (2, 2) and D (1, 2). Under an enlargement the vertices of its image are A'(1, 1), B'(5, 1), C '(5, 5) and D' (1, 5), find the centre and scale factor of the enlargement. (4 marks)

(14) The model of an aircraft is designed such that the volume of its interior space is 125cm^3. The volume of the airspace of the actual aircraft is 3375 litres.

(a) Given that the wing span of the actual aircraft is 7.44m, find the wing span of the model in centimetres. (4 marks)

(b) If the total surface area of the model is 2420cm^2, find the total surface area of the actual aircraft in square metres. (4 marks)

(c) Calculate the cost of the material used to build the actual aircraft if the cost of material is 25 US Dollars per square metre. (2 marks)

Appendix 4: Mathematics Self- Concept Questionnaire (MSCQ)

School ____ Form __________

Male/Female_______________________ Age___________________

We would like to know your feelings about mathematics. Your answers are confidential and will only be used for this research. Your answers will not be used in any way to refer to you as an individual.

Instructions

1. Answer all questions
2. This is not a test and there are no correct or wrong answers.
3. It is important that you give your honest view.
4. Give your own views about yourself without talking to others.
5. Read the items with care in order to understand before marking your choice.
6. Circle around the letter(s) that correspond to your choice.
7. The letter choices are SD = Strongly Disagree, D= Disagree, U = Uncertain, A = Agree and SA =Strongly Agree.

Example: Mathematics plays an important role in one's life.

SD D U A SA

In the example the respondent strongly agreed with the statement and circled the letters SA.

Now use the key provided to indicate your level of feeling with the items listed below.

ITEMS	CHOICE
1. Mathematics in one of my best subjects.	SD D U A SA
2. I often need help in mathematics.	SD D U A SA
3. I look forward to mathematics classes.	SD D U A SA
4. I have trouble understanding anything with mathematics in it.	SD D U A SA
5. I enjoy studying for mathematics.	SD D U A SA
6. I do badly in tests of mathematics.	SD D U A SA
7. I am good at mathematics.	SD D U A SA
8. I never want to take another mathematics course.	SD D U A SA
9. I have always done well in mathematics.	SD D U A SA
10. I hate mathematics.	SD D U A SA
11. People come to me for help in Mathematics.	SD D U A SA
12. If I work really hard I could be one of the best students in Mathematics.	SD D U A SA

13. I get bad marks in Mathematics.	SD	D	U	A	SA
14. I learn things quickly in Mathematics.	SD	D	U	A	SA
15. I am stupid at Mathematics.	SD	D	U	A	SA
16. I do well in tests in Mathematics.	SD	D	U	A	SA
17. I have trouble with Mathematics.	SD	D	U	A	SA
18. I am hopeless in Mathematics.	SD	D	U	A	SA
19. Mathematics subject is just too hard for me.	SD	D	U	A	SA
20. I enjoy doing mathematics with my friends.	SD	D	U	A	SA

Appendix 5: Mathematics Learning Environment Questionnaire (MLEQ)

School_____________________________ Form____________________

We are interested to know what you perceive about the mathematics classroom learning environment during the teaching and learning of mathematics.

Instructions

(1) This is not a test and there are no correct or wrong answers.

(2) It is important that you give your honest view.

(3) Read the items carefully and understand before choosing what truly reflects your perception of the classroom learning environment during mathematics lessons.

(4) Using the given scale, indicate your agreement with each item by placing a cycle around the letter(s) representing the selected option.

(5) Scale: SA=Strongly Agree, A =Agree U = Undecided, D=Disagree, SD =Strongly disagree.

Example: A student who agrees with the following statement would answer as follows

The lesson was interesting. SA A U D SD

ITEM	CHOICE
1. We are encouraged to ask questions during mathematics lessons.	SA A U D SD
2. The teacher praises us for correct answers to questions asked in class.	SA A U D SD
3. The teacher uses examples to explain concepts during mathematics lessons.	SA A U D SD
4. We are allocated time during lessons to solve problems from books and past papers.	SA A U D SD
5. Students are allowed to discuss in groups mathematics problems given in class.	SA A U D SD
6. The teacher expects us to solve problems given in class individually.	SA A U D SD
7. Mathematics lessons are organized in such a way that students can concentrate throughout the session.	SA A U D SD
8. The conducive climate in class makes learning mathematics interesting.	SA A U D SD
9. The mathematics lessons are well planned.	SA A U D SD

10. Students are given opportunities to actively participate in discussions during mathematics lessons. SA A U D SD

11. Boys are given more opportunities to engage in class discussions than girls. SA A U D SD

12. We are allocated time to copy notes during mathematics lessons. SA A U D SD

13. Our teacher pays more attention to girls in class than boys. SA A U D SD

14. We worked in groups during mathematics lessons. SA A U D SD

15. The relationship among students during mathematics lessons is very friendly. SA A U D SD

16. The assignments given at the end of every lesson makes me feel eager to learn mathematics. . SA A U D SD

17. Discussions organized by the teacher during lessons help us a lot to learn mathematics. SA A U D SD

18. We depended on each other more than the teacher when solving problems during mathematics lessons. SA A U D SD

19. The mathematics lessons are organized in such a way that we always compete against each other. SA A U D SD

Appendix 6: Research Permit

THIS IS TO CERTIFY THAT:
MR. JOHN KIHIATO GICHOHI
of EGERTON UNIVERSITY , 379-10100
NYERI,has been permitted to conduct
research in *Nyeri County*

Permit No : NACOSTI/P/17/53607/19622
Date Of Issue : 30th October,2017
Fee Recieved :Ksh 1000

on the topic: *EFFECTS OF TEAMS - GAMES - TOURNAMENTS COOPERATIVE LEARNING ON MATHEMATICS ACHIEVEMENT IN PUPLIC SECONDARY SCHOOLS IN NYERI CENTRAL SUB-COUNTY, KENYA*

for the period ending:
30th October,2018

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

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RESEARCH CLEARANCE PERMIT

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CONDITIONS: see back page

Appendix 7: Published Paper

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EFFECTS OF TEAMS - GAMES - TOURNAMENTS COOPERATIVE LEARNING ON STUDENTS' MATHEMATICS ACHIEVEMENT IN PUBL 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. Quasi-experimental Solomon Four Non-Equivalent Control Group Design was used in the study. The target population was all secondary school students in Nyeri 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

Appendix 8: Key Data Analysis Outputs

```
. summarize

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       mate1 |         45        1.93     1.50277   .1571421   6.135761
       matc1 |         53        1.78    1.471905   .0093516    7.06581
      mscqe1 |         45         3.2    1.081261   .9713305   7.477437
      mscqc1 |         52        2.95    .4932511   1.780981   4.044432
      mleqe1 |         45        3.49    .4801801   2.479588   5.175042
-------------+---------------------------------------------------------
      mleqc1 |         57        3.36    .5584821   2.303682   6.281308
```

```
. ttest mate1 == matc1, unpaired

Two-sample t test with equal variances
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
   mate1 |      45        1.93    .2240197     1.50277    1.478518    2.381482
   matc1 |      53        1.78    .2021817    1.471905    1.374293    2.185707
---------+--------------------------------------------------------------------
combined |      98    1.848878    .1495388    1.480359    1.552084    2.145671
---------+--------------------------------------------------------------------
    diff |                 .15    0.3885513               -.447975     .747975
------------------------------------------------------------------------------
    diff = mean(mate1) - mean(matc1)                              t =   0.3860
Ho: diff = 0                                     degrees of freedom =       96

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.6902         Pr(|T| > |t|) = 0.7012          Pr(T > t) = 0.3098
```

```
. ttest mscqe1 == mscqc1, unpaired

Two-sample t test with equal variances
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  mscqe1 |      45         3.2    .1611849    1.081261    2.875153    3.524847
  mscqc1 |      52        2.95    .0684016    .4932511    2.812678    3.087322
---------+--------------------------------------------------------------------
combined |      97    3.065979    .0837772    .8251098    2.899683    3.232276
---------+--------------------------------------------------------------------
    diff |                 .25     .146545               -.0813682    .5813682
------------------------------------------------------------------------------
    diff = mean(mscqe1) - mean(mscqc1)                            t =   1.7060
Ho: diff = 0                                     degrees of freedom =       95

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9312         Pr(|T| > |t|) = 0.1375          Pr(T > t) = 0.0688
```

```
. ttest mleqe1 == mleqc1, unpaired

Two-sample t test with equal variances
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
  mleqe1 |      45        3.49     .071581    .4801801    3.345738    3.634262
  mleqc1 |      57        3.36    .0739728    .5584821    3.211815    3.508185
---------+--------------------------------------------------------------------
combined |     102    3.417353    .0521678    .5268693    3.313866     3.52084
---------+--------------------------------------------------------------------
    diff |                 .13     . 082085               -.0778924    .3378924
------------------------------------------------------------------------------
    diff = mean(mleqe1) - mean(mleqc1)                            t =   1.5840
Ho: diff = 0                                     degrees of freedom =      100

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8912         Pr(|T| > |t|) = 0.2176          Pr(T > t) = 0.1088
```

```
. summarize

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
       mate1 |         45        1.93     1.50277   .1571421   6.135761
       matc1 |         53        1.78    1.471905   .0093516    7.06581
      mscqe1 |         45         3.2    1.081261   .9713305   7.477437
      mscqc1 |         52        2.95    .4932511   1.780981   4.044432
      mleqe1 |         45        3.49    .4801801   2.479588   5.175042
-------------+---------------------------------------------------------
      mleqc1 |         57        3.36    .5584821   2.303682   6.281308
```