EFFECTS OF COOPERATIVE LEARNING APPROACH ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN KANGEMA DISTRICT, MURANG'A COUNTY, KENYA

BY:
KAMAU PATRICK MWANGI
REG.NO.E55/CE/22899/2010

A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF THE MASTER OF EDUCATION IN THE SCHOOL OF EDUCATION OF KENYATTA UNIVERSITY

SEPTEMBER 2015
DECLARATION

This thesis is my original work and has not been presented to any other university or institution for examination

Signature: 

Date: 09/10/15

KAMAU PATRICK MWANGI
E55/22899/2010

Supervisors:
I/we confirm that the work reported in this thesis was carried out by the candidate under my/our supervision as university supervisor(s)

DR. SIMON MERU RUKANGU
Department of Educational communication and Technology
Kenyatta university
Signature: 
Date: 14/10/2015

DR. SAMSON ONDIGI
Department of Educational Communication and technology
Kenyatta University
Signature: 
Date: 12/07/15
DEDICATION

This work is dedicated to my wife Philomena Mwangi whose inspiration made me undertake the course. I also dedicate it to my two sons, Robert Kamau and Collins Njoroge for their constant encouragement and patience during the entire learning period.
# TABLE OF CONTENTS

DECLARATION .......................................................... ii  
DEDICATION ............................................................ iii  
ACKNOWLEDGEMENT ..................................................... viii  
LIST OF TABLES ......................................................... ix  
LIST OF FIGURES ......................................................... x  
ABBREVIATIONS AND ACRONYMS ...................................... xi  
ABSTRACT .............................................................. xii  

CHAPTER ONE ................................................................. 1  
1.1 Background of the study ............................................. 1  
Table 1.1: Showing National mean score in mathematics 2007-2010 .............. 1  
Table 1.2 Student performance in science and mathematics in Kangema District, 2010 ................................................ 2  
1.2 Statement of the problem ............................................ 3  
1.2.1 Purpose of the study .............................................. 4  
1.3 Specific objectives of the study ..................................... 4  
1.4 Hypothesis of the study ............................................. 4  
1.5 Significance of the study ............................................ 5  
1.6 Assumptions of the study ........................................... 6  
1.7 Scope of the study .................................................. 6  
1.7.1 Limitations of the study ......................................... 7  
1.8 Theoretical framework ............................................. 7  
1.8.1 The Conceptual framework ..................................... 8  
1.9 Operational Definition of terms .................................. 10  

CHAPTER TWO ................................................................. 11  
LITERATURE REVIEW .................................................... 11  
2.1 INTRODUCTION .................................................... 11  
2.2 COOPERATIVE LEARNING ......................................... 11  
2.3 Need to use cooperative groups .................................... 13
2.4 Theoretical Basis of Cooperative Learning and Achievement ............................................. 15
  2.4.1 Motivational perspectives ......................................................................................... 15
  2.4.2 Social Cohesion Perspectives .................................................................................. 17
  2.4.3 Cognitive Perspectives ........................................................................................... 18
  2.4.4 Developmental perspectives ................................................................................... 18
  2.4.5 Cognitive elaboration perspectives ......................................................................... 20
  2.5 Rationale for Cooperative Learning ............................................................................ 22
  2.6 Uniqueness of Cooperative Learning ......................................................................... 23
  2.7 Disadvantages of Cooperative Learning .................................................................... 24
  2.8 Implementation of Cooperative Learning in the Classroom ....................................... 24
    2.8.1 Class Presentations ............................................................................................... 25
    2.8.2 Learning Teams .................................................................................................... 25
    2.8.3 Individual Quizzes ............................................................................................... 26
    2.8.4 Individual Improvement Scores .......................................................................... 26
    2.8.5 Team Recognition ............................................................................................... 26
    2.8.6 Materials .............................................................................................................. 26
    2.8.7 Assigning Students to Team ................................................................................. 27
    2.8.8 Team Building ...................................................................................................... 27
    2.8.9 Schedule of Activities ......................................................................................... 27
    2.8.10 Mathematics and Cooperative Learning ............................................................ 28

CHAPTER THREE .................................................................................................................. 30
RESEARCH METHODOLOGY .............................................................................................. 30
  3.1 Introduction .................................................................................................................. 30
  3.2 Research Design .......................................................................................................... 30
  3.3 Location of study ......................................................................................................... 31
  3.4 Target Population ........................................................................................................ 32
  3.5 Sampling procedures ................................................................................................. 32
  3.6 Sample Size ................................................................................................................. 32
  3.7 Research Instruments ................................................................................................. 33
  The study employed five (5) instruments namely: .......................................................... 33
    3.8 Pilot study .................................................................................................................. 34
    3.8.1 Validity .................................................................................................................. 34
3.8.2 Reliability ............................................................................................................. 34
3.9 Data collection ......................................................................................................... 35
3.10 Data analysis .......................................................................................................... 36
3.11 Logical and ethical considerations ......................................................................... 37
3.12 Conclusion .............................................................................................................. 37

CHAPTER FOUR ........................................................................................................... 38
REPORTING AND DISCUSSION OF THE FINDINGS ....................................................... 38
4.1 Introduction .............................................................................................................. 38
4.2 Data analysis presentation and interpretation ......................................................... 38
The mode of date collection was by a mathematics teacher’s questionnaire, student’s questionnaires before and after treatment and pretest before the experiment and a post test after the treatment. .............. 38
4.3 Response Rate ....................................................................................................... 38
4.4 Academic qualification of the mathematics teachers .............................................. 39
4.4.1 Years of service in teaching mathematics ....................................................... 40
4.5 Academic achievements of students in mathematics .......................................... 41
4.6 Effects of the cooperative learning Strategy on the Students’ Achievement ...... 42
4.7 Students attitudes towards cooperative learning ................................................. 47

CHAPTER FIVE ............................................................................................................. 55
SUMMARY, CONCLUSION AND RECOMMENDATIONS .............................................. 55
5.1 Introduction .............................................................................................................. 55
5.2 Summaries of the main findings of the study......................................................... 55
5.3 Conclusion .............................................................................................................. 57
5.4 Recommendations ................................................................................................. 58
5.5 Suggestions for further research .......................................................................... 58
REFERENCES ............................................................................................................... 59

APPENDICES .............................................................................................................. 65
APPENDIX A: STUDENT PRE PROJECT SURVEY .................................................... 65
APPENDIX B: PRE-TEST ............................................................................................ 67
APPENDIX C: POST-TEST .......................................................................................... 68
APPENDIX D: STUDENT POST- PROJECT SURVEY ............................................... 69
APPENDIX E – TEACHERS MANUAL FOR CONDUCTING COOPERATIVE LEARNING .. 70
APPENDIX F: MATHEMATICS TEACHERS QUESTIONNAIRE ............................... 73
ACKNOWLEDGEMENT

I extend my most sincere gratitude to my supervisors, Dr. Samson Ondigi and Dr. Simon Meru Rukangu for their constant guidance without which this study would not have become a reality. Thanks to the principals and the mathematics teachers of the schools that were involved in the study for their assistance during the study period. I wish also to thank the examiners who read through the document and offered very valuable collections. Thanks to the office of the sub-county director of education Kangema for the permission to conduct the research in the sub-county and also for willingly availing data which was necessary for the study.
LIST OF TABLES

Table 1.1: Showing national mean score in mathematics 2007-2010 .....................1
Table 1.2: Student performance in science and mathematics in Kangema district, 2010 ... 2
Table 4.1: Response rate .................................................................................34
Table 4.2: Academic qualification of the teachers ...........................................35
Table 4.3 Teaching experience of the mathematics teachers ...........................36
Table 4.4: Pre-test mean scores on cooperative learning and t-value results ..........37
Table 4.5: Effects of cooperative learning.......................................................38
Table 4.6: Students post-test mean scores .......................................................39
Table 4.7: ANOVA results ..............................................................................40
Table 4.8: Test of homogeneity of variances ..................................................40
Table 4.9: Post hoc comparisons of the cooperative post-test scores for the four Groups .................................................................41
Table 4.10: Response of experimental group students before Experiment .............43
Table 4.11: Response of experimental group students after Experiment ...............45
LIST OF FIGURES

Fig 1: The conceptual framework used to investigate the effects of cooperative Learning approach on students mathematics achievement.................................7
Figure 2: Bar graphs showing the students response on pre-project survey .................44
Figure 3: Bar graphs showing the students response on post-project survey ...............46
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANOVA</td>
<td>Analysis Of Variance</td>
</tr>
<tr>
<td>KCPE</td>
<td>Kenya Certificate of Primary Education</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>MAT</td>
<td>Mathematics Achievement Test</td>
</tr>
<tr>
<td>RTM</td>
<td>Regular teaching methods</td>
</tr>
<tr>
<td>STAD</td>
<td>Student Team Achievement Division</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>ZPD</td>
<td>Zone of Proximal Development</td>
</tr>
</tbody>
</table>
ABSTRACT

This study was aimed at finding out the effects of cooperative learning approach on student’s achievement in mathematics. It sought to investigate whether the use of cooperative learning groups changed students individual achievement and students attitude towards cooperative learning in mathematics. The study was guided by the following objectives: To investigate whether cooperative learning method is more effective than the Regular methods of teaching (RMT) with respect to students academic achievement in mathematics; and to establish the attitudinal change towards cooperative learning as a method of learning mathematics. This study employed a Quasi-experiment and Solomon’s four non-equivalent control group research design. The target population comprised of secondary school students in Kangema sub-county of Muranga county. The unit of sampling was the secondary school rather than the students since schools authority do not allow classes to be dismantled for research purposes. Purposive sampling was used to obtain a sample of four co-educational schools. Each school provided one form two class for the study which was considered as a group. Each of the form two classes was randomly assigned to each of the four groups. The groups were: Group 1(experimental)-34 students, Group 2(control)-31 students, Group 3(experimental)-33 students and Group 4(control)-30 students. A total of 128 students were involved. The researcher trained the teachers of the experimental groups on the techniques of cooperative learning using a pre-prepared manual for a period of one week. The instruments used in the study were: a semi-standardized instrument measuring the attitudes on a three point Likert scale. This was to assess how the attitude towards cooperative learning changed during the course of the experiment. A Mathematics Achievement Test (MAT) was used as pre-test and a post-test to measure the achievement. The instruments were pilot tested using a different school in the sub-county but with similar characteristics as the sample schools. The reliability coefficient of the MAT and the attitude instrument were 0.86 and 0.81 respectively. Mathematics K.C.S.E senior examiners ascertained the content validity of the instruments. Prior to the experiment and after the experiment, students in the experimental groups filled the attitude questionnaire. Students in group 1 and group 2 received the pre-test while groups 3 and 4 did not. All the students were taught the topic on evaluation of numerical expressions using logarithms. In the experimental groups, cooperative learning approach was used while Regular Teaching Methods (RTM) was used in the control groups for a period of three weeks, after which all the groups received a post-test. Data was analyzed using descriptive and inferential statistics. Test hypothesis was accepted or rejected at a significance level of 0.05. Findings of this study show that learners taught using cooperative learning technique performed better than those taught using Regular teaching methods. The attitudes towards cooperatively learning mathematics together in small groups also improved. The study recommends that the teacher should use cooperative learning approach side by side with other individual learning approaches because cooperative learning approach does not replace direct instructions but supplements other teaching approaches. The study also recommends that cooperative learning strategy be incorporated in the teacher education programs and in the in-service courses for mathematics teachers.
CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Mathematics is a compulsory subject for all students in Kenya up to form four levels KNEC (2005). This is necessitated by the fact that knowledge of mathematics is essential for all members of society (Stanic (1989).

Mathematics need not be learned by student in secondary school for the sake of career choice or advancement, but students should be able to learn mathematics with understanding and therefore be able to apply mathematical ideas later in life (Cockcroft, 1982). In secondary schools more lessons of mathematics are taught than those of sciences. Despite concerted efforts of teachers to enhance learning of mathematics among secondary students, performance and success in learning mathematics is still unsatisfactory. According to SMASSE project Report (1998), the reason for the dismal performance in mathematics examination are likely to be due to formed attitudes towards the subject by the students, teaching methods which are not appropriate and lack of resources among others. Over the years the performance in mathematics in secondary schools has been raising a lot of concern. Table 1.1 shows the national mean score in mathematics for the last four years.

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>19.73</td>
<td>19.31</td>
<td>18.60</td>
<td>15.96</td>
</tr>
</tbody>
</table>
In 2010 the mean score was at its worst standing at 15.96 with the trend going down from 2007. This is a clear indicator that despite many researches on poor performance in mathematics at the national level, the causes have not been adequately found or the recommendations of the researches have not been fully implemented. K.C.S.E. data available from Kangema Education Office indicated that Mathematics was the worst performed subject in 2010 compared with the sciences. This is evident in the scores shown in table 1.2.

Table 1.2 Student performance in science and mathematics in Kangema District, 2010

<table>
<thead>
<tr>
<th>Subject</th>
<th>ENT</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
<th>X</th>
<th>Y</th>
<th>M/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>3251</td>
<td>39</td>
<td>40</td>
<td>43</td>
<td>89</td>
<td>93</td>
<td>112</td>
<td>173</td>
<td>202</td>
<td>214</td>
<td>507</td>
<td>760</td>
<td>969</td>
<td>14</td>
<td>0</td>
<td>3.378</td>
</tr>
<tr>
<td>Chem.</td>
<td>3005</td>
<td>29</td>
<td>54</td>
<td>76</td>
<td>86</td>
<td>103</td>
<td>149</td>
<td>185</td>
<td>223</td>
<td>248</td>
<td>801</td>
<td>832</td>
<td>209</td>
<td>11</td>
<td>1</td>
<td>3.954</td>
</tr>
<tr>
<td>Phy</td>
<td>1025</td>
<td>14</td>
<td>8</td>
<td>44</td>
<td>53</td>
<td>51</td>
<td>103</td>
<td>132</td>
<td>111</td>
<td>85</td>
<td>202</td>
<td>170</td>
<td>52</td>
<td>3</td>
<td>0</td>
<td>4.954</td>
</tr>
<tr>
<td>Bio</td>
<td>2127</td>
<td>5</td>
<td>19</td>
<td>70</td>
<td>10</td>
<td>150</td>
<td>187</td>
<td>265</td>
<td>287</td>
<td>314</td>
<td>833</td>
<td>403</td>
<td>58</td>
<td>11</td>
<td>9</td>
<td>4.463</td>
</tr>
</tbody>
</table>

Approximately 53.1% of the students who sat for KCSE mathematics in that year scored between D- and E, meaning that more than half of the candidates could not join mathematics and science related courses, a prerequisite for the realization of the country's vision 2030.

The low grades may be improved if learning of the subject was enhanced by ensuring that students had favourable attitudes towards the subject and towards the learning process itself. This can be enhanced if the learning process becomes more interesting and more students centered. This may be realized if cooperation methods are used in our classrooms. It is therefore the intention of this research to investigate the effectiveness of cooperative learning methods through an experimental approach.
1.2 Statement of the problem

The poor performance as reflected by the K.C.S.E. Examination results in Mathematics has
continued to trigger a lot of concern among educationists and other stakeholders nationally. This
poor performance in Mathematics among other factors is likely to undermine the attainment of
the projected goals as envisaged in the vision 2030 development strategic plan. The teaching
method is a crucial factor that may affect students participation in the learning process, motiva-
tion and consequently achievement. The use of traditional methods of teaching have been
cited as one of the major contribution to mass failures of students in mathematics. In attempt to
address this issue, the present study explored the effects of cooperative learning approach on the
academic achievement in mathematics. Robertson (1999) reported cooperative learning as a
viable and effective instructional methodology for teaching and learning mathematics. It helps to
make mathematics exciting and enjoyable for both students and teachers. Cooperative strategies
can be integrated at any grade level and for any mathematics topic. Students learn to cooperate
with others and to communicate in the language of mathematics. The classroom atmosphere
tends to be relaxed and informal, help is readily available, questions are freely asked and
answered and even the shy students find it easy to be relaxed. Many students maintain a high
level of interest in the mathematics activities and have an opportunity to pursue the more
challenging and creative aspects of mathematics. Several studies have examined the effects of
cooperative learning methods on student learning. Humphreys et al, (1982) compared
cooporative, competitive and individualistic strategies in science classes and found that students
taught by cooperative methods learned and retained significantly more information than students
taught by the other two methods.
This method of teaching has not been tried out in mathematics and learning in Kangema District where performance in the subject has continued to decline. This study aimed at finding out the effects of cooperative learning approach in the teaching of mathematics in the district.

The use of cooperative learning approach in teaching mathematics is likely to help improve the student's academic achievement. The available research does not indicate any research in the effects of cooperative learning approach in secondary mathematics in Kangema district. This study is therefore intended to fill this gap in the body of knowledge.

1.2.1 Purpose of the study

The purpose of the study was to investigate the effects of using cooperative learning approach on student’s achievement in secondary school mathematics.

1.3 Specific objectives of the study

The objectives of the study were:

i. To investigate whether the cooperative learning method is more effective than the regular methods of teaching with respect to academic achievement of students in mathematics.

ii. To establish the attitudinal change towards cooperative learning as a method of learning mathematics.

1.4 Hypothesis of the study

The following null hypothesis was tested in this study at a significance alpha level of 0.05.

$H_0$: There is no statistically significance difference in achievement in Mathematics between students who are exposed to cooperative learning and those who are not exposed to it.
1.5 Significance of the study

The aim of the study was to contribute towards the improvement of teaching and learning of mathematics at secondary school level. The knowledge of cooperative methods in teaching and learning mathematics can encourage learner participation and effectively improve communication and interaction in secondary schools mathematics lessons. As a result the findings will add to the existing knowledge of classroom research, hence and hopefully student’s performance will be improved. Specifically, the findings of this study will be significant to the following stakeholders.

Teachers

The finding will assist teachers to evaluate their teaching methods. While cooperative learning as an instructional methodology is an option for teachers, it is currently the least frequently used. More than 85% of the instructions in schools consist of lecturers, seatwork, or competition in which students are passive listeners. Goodland (1984) reported that most classroom time is spent in “teacher talk”, with only 1% of the students classroom time used for reasoning about or expressing an opinion. This completely loses the weak learner especially in mathematics. Teachers will know when and how to improve students participation in the process of teaching and learning mathematics.
Students

Students on the other hand, have the responsibility of initiating classroom interactions for their proper understanding of mathematical concepts. Johnson and Ahlgren (1976) examined the relationships between student’s attitudes towards cooperation, competition and their attitudes towards education. The result of the study indicated that student cooperativeness, and not competitiveness was positively related to being motivated to learn.

Teacher trainers

They will use the findings while preparing their secondary school mathematics teachers syllabuses. Teachers to be exposed to in-depth training that incorporates more of learner participation than the teacher. They will modify their training especially during micro-teaching skills. This will equip teacher trainees with appropriate skills to use during their mathematics teaching.

1.6 Assumptions of the study

i. Teachers used in the study were well trained and have good mastery of the subject content.

ii. There were adequate textbooks and other relevant teaching resources, for teaching the selected study topics.

iii. The study groups were of similar learning backgrounds and that any learning outcome was as a result of the classroom experiences and interactions.

1.7 Scope of the study

i. Only four secondary school of Kangema district Murang’a county were involved in the study.
ii. Form two students in this study had been 150 marks-300 marks at KCPE level out of the possible 500 marks.

1.7.1 Limitations of the study

The study faced the following constraints:

i. First, the principals of the schools involved in the study were unwilling to host the study. However the study overcame this limitation by explaining to them the purpose of the study. They were assured that the findings would in no way be used for evaluation of their schools.

ii. Teachers abrupt official engagement during the study which made the researcher and the teachers to reschedule the lessons thereby interrupting the flow of the study

iii. Limited resources. The principals and the teachers of the participating schools did not receive compensation for their participation.

1.8 Theoretical framework

According to Slavin (1987), there are two major theoretical perspectives related to cooperative learning motivational and cognitive. The motivational theories of cooperative learning emphasize the students incentives to do academic work, while the cognitive theories emphasize the effects of working together. Motivational theories related to cooperative learning focus on reward and goal structures. One of the elements of cooperative learning is positive interdependence, where students perceive that their success or failure lies within their working together as a group (Johnson, Johnson, & Holubec 1986). From a motivational perspective, "cooperative goal structure creates a situation in which the only way group members can attain their personal goals is if the group is successful" (Slavin 1990). Therefore in order to attain their personal goals, students are likely to encourage members within the group to do whatever helps
the group to succeed and to help one another with a group task. There are two cognitive theories that are directly applied to cooperative learning. The developmental and the elaborative learning theories (Slavin 1987). The developmental theories assume that interaction among students around appropriate tasks increases their mastery of critical concepts (Damon, 1984). When students interact with other students, they have to explain and discuss each others perspectives, which lead to greater understanding of the material to be learned. The struggle to resolve potential conflicts during collaborative activity results in the development of levels of understanding (Slavin, 1990). The elaboration theory suggests that one of the most effective means of learning is to explain the material to someone else. Cooperative learning activities enhance elaborate thinking and more frequent giving and receiving of explanations, which has the potential to increase depth of understanding, the quality of reasoning, and the accuracy of long term retention (Johnson, Johnson & Holubec, 1986). Therefore, the use of cooperative learning methods should lead to improved student learning and retention from both the developmental and cognitive theoretical bases.

1.8.1 The Conceptual framework

The conceptual framework (Figure 1) of this study was based on the systems theory developed by Ayot and Patel (1987) and Gerlach and Ely (1980) that portrayed the teaching-learning process as dynamic with inputs and outputs with the assumption that teaching methods that involved students cooperation led to worthwhile learning (Hanrahan, 1998). The study involved guided discovery in which teachers played the key roles of planning and facilitating learning.
Fig 1: The Conceptual framework used to investigate the effects of cooperative learning approach on students Mathematics achievement. Source: Ayot and Patel (1987)

The figure shows the relationship of variables for determining the effects of using cooperative learning on secondary student’s achievement in mathematics. Learning outcomes are influenced by various factors. These include; learner characteristics, classroom environment and teacher characteristics as shown in fig 1. These are the extraneous variables which will need to be controlled.

Teacher training determine the teaching approach a teacher uses and how effective the teacher will use the approach. The learner’s age and hence their class determines what they are taught.

The type of school as a teaching environment affects the learning outcome. The study involved trained mathematics teachers to control the teacher variable. The type of school used is co-educational to control the effect of the classroom environment. Form two
students who are approximately of the same age were involved in the study. In the study therefore the teaching method that was used influenced the learning outcomes.

1.9 Operational Definition of terms

**Attitude** – Refers to positive or negative pre-deposition of thinking, feeling perceiving and behaviour in a certain way towards a given situation.

**Curriculum** – All that the school has planned to enable the students to acquire and develop the desired knowledge, skills and attitudes.

**John Henry effect**- A tendency for members of the control group in certain experiments to adopt a competitive attitude towards the experimental group, thereby negating their status as controls.

**Learning resource** – Any person, materials or events that will give a condition that enables the learner to acquire the expected knowledge, attitude and skills.

**Pedagogy** – Methodology of the teaching practice associated with classroom organization and differentiation of instructional opportunities.

**Performance** – Successful accomplishment or achievement in a particular subject area of course.

**Regular Teaching Methods** - sequential, didactic instruction that uses the lecture method as its principal delivery system. The instructor is seen as the deliverer of knowledge and the student the receiver of the instruction

**Solomon four non equivalent groups**- An experimental research design comprising two experimental groups and two control groups. Two groups(one experimental and another one control) are both subjected to a pre-test and a post-test. The other two are exposed only to a post-test, where one of this is subjected to the intervening condition while the other is a control group.
CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION
The study is designed to examine the effect of cooperative learning on academic achievement of secondary school students in mathematics. Review of related literature includes the following areas.

2.2 COOPERATIVE LEARNING
Cooperative learning is a set of teaching strategies used to promote face-to-face interaction among students and help them reach specific learning and inter-personal goals in structured groups (Johnson and Johnson 1994; Slavin, 1997).

Cooperative learning strategies may be informal groupings that allow students to work together. They may be structured, with students having specific tasks in their group and assessing their group and individual performance. While cooperative learning groups generally involve four members, the number of students may be greater or fewer. Groups may work together for a few minutes, a couple of weeks or for many months. (Slavin, 1997) Johnson and Johnson (1994) described three types of cooperative learning groups: Cooperative base, informal cooperative learning and formal cooperative learning groups.

Cooperative base groups are long-term heterogenous learning groups with stable membership (Richards and Rodgers 2001) which may last an year or more. This type of grouping is established to provide support, encouragement and assistance among the students to achieve academic goals.

The students in those groups are also responsible to check their team member's attendance to lesson and completion of assignments. They may also discuss their personal problems in learning...
informal cooperative learning groups are short-term grouping in which membership is usually random. The main purpose of informal cooperative groups is to focus student’s attention on the materials and facilitate learning during direct teaching. Short pre- or post-lecture discussions, round robin, and think-pair share are among the activities that can be used in this kind of cooperative learning groups. In formal cooperative learning groups, students work together on specific tasks to achieve shared learning goals or complete a given assignment. Those groups may last from one class period to several weeks. Kagan and Kagan (1994) have shown that the students acquire social skills with cooperative learning. They state when cooperative learning is used, students learn to understand, respect and support one another. In addition, other studies in the field have shown that cooperative learning improves students self-esteem, enables them to establish positive interpersonal relationships, and fosters positive interdependence. Johnson and Johnson, (1992) Stahl (1995) noted that cooperative learning encourages students to interact, ask and answer questions, solve problems and make decisions. Cooperative learning helps teachers create a positive affective classroom atmosphere in which psychological barriers, such as student anxiety are lowered and self confidence and self-esteem are increased. (Crandall 1999; Donyei 1997; oxford, 1997). As Crandall (1999) states, students anxiety results from making mistakes, especially when they are asked a question to be answered individually. When students are allowed to study together, they have more time to think, to share their opinion with others, receive feedback from them and correct any mistakes. As a result, their anxiety level is reduced, and they become willing to participate in answering the questions of the teacher. This often results in enhanced self confidence and self-esteem (Crandall 1999; Donyei 1997)
The roles of the students in cooperative class are significantly different from their roles in the
classroom; they are no longer trying to impress their teacher but are
busy learning actively.
Kirby (2007) conducted an action research of cooperative learning in an accounting class at a
high school in rural Jamaica. The researchers aim was to find out how effective the use of
cooperaive learning is in improving academic performance among grade nine (9) students. The
study was descriptive design with sample size thirty (30) students. Kirby (2007) collected the
data from a questionnaire. only 28% of students thought that accounting class was interesting
using traditional teaching strategies. However this increased to 86% after the implementation of
cooperaive learning strategies, overall, students believed that cooperative learning positively
imparted on their learning experience.
The following includes the specific conclusions from Kirby’s study.
There was an improvement in the minimum and maximum scores of students. Students believed
that cooperative learning allowed for a more relaxing environment where they exhibited better
understanding.
Student’s self-esteem was enhanced; they stated that they felt more comfortable in answering
questions. Students were more accepting of the help received from peers and they did not feel
inferior to any other students as they all helped one another. Students developed team spirit
during and after implementation. Competition was eliminated and all group members were
focused on ensuring that everyone understood what was being taught.

2.3 Need to use cooperative groups
Several recent reports urging reform of mathematics and science education in general (e.g.
National Council of Teacher of Mathematics 1989, 1999, National Research Council 1989) and
statistics education in particular (cabb 1992), have described the need for specific change in teaching. Instead of traditional lecturers where teachers “tell” students information that they are to “remember” teachers are encouraged to introduce active learning activities where students are able to construct knowledge. One way for teachers to incorporate active learning in their classes is to structure opportunities for students to learn together in small groups.

A majority of the published research studies examine cooperative learning activities in elementary and secondary schools, and subgroup of these activities focus on mathematics classes. The implication of these studies is that the use of small groups learning activities leads to better group productivity. Another argument for using cooperative learning groups relates to the constructivist theory of learning, on which much of the current reform in mathematics and science education is based. This theory describes learning as actively constructing one’s own knowledge. Constructivists view students as bringing to the classroom their own ideas, experiences, and beliefs that affect how they understand and learn new material. Rather than “receiving” material in class as it is “delivered”, students restructure the new information to fit into their prior knowledge, rather than copying knowledge “transmitted” or “conveyed” to them. Small group learning activities may be designed to encourage students to construct knowledge as they learn new material, transforming the classroom into a community of learners, actively working together to understand new concepts. The role of the teacher changes accordingly from that of “source of information” to that of a “facilitator of learning” part of this role is to be an ongoing assessor of student learning.
Businesses are increasingly looking for employees who are able to work collaboratively on projects and solve problems as a team. Therefore it is important to give students practice in developing these skills by working cooperatively on a variety of activities. This type of experience will not only build collaborative problem-solving skills but will also help students to learn to respect others' viewpoints, other approaches to solving a problem and other learning styles.

2.4 Theoretical Basis of Cooperative Learning and Achievement

Most of the development work on cooperative has been nurtured in the last three decades of 20\textsuperscript{th} century when too much had been explored about the learning process. Therefore the roots of cooperative learning lie deep in learning theories. Study of related literature provides us a sound theoretical framework and conceptual base for cooperative learning. Most of the researchers (e.g. Slavin 1996, Johnson & Johnson 1999) have described cooperative learning on five major theoretical perspectives.

Motivational perspectives

Social cohesion perspectives

Cognitive perspectives

Developmental perspectives

Cognitive elaboration perspectives

2.4.1 Motivational perspectives

Motivational perspectives on cooperative learning assume that cooperative efforts are based on group reward or goal structures (Slavin 1987). From a motivational perspective, cooperative
learning activities, when properly carried out, create a situation in which individual group members can achieve their goals if and only if each member is successful. Therefore, the members of the group are motivated to help their classmates in order to meet their own goals. And even more importantly, they encourage their group-mates to exert maximum efforts. This gives rise to interpersonal reward structure in which group members withhold social reinforcers in response to group-mates task related efforts (Slavin, 1987). Thus, due to cooperative goal; structures as identified by Deutsch (1949), cooperative learning encourages students to want their classmates to succeed in contrast, to competitive learning where individuals compete for grades, or individualistic goal structures where individuals have no concern with the attainment of others.

Johnson and Johnson (1999) and Slavin (1987) have adopted motivational concerns of cooperative learning from behavioral and humanistic learning theories. Two important behaviorist concepts are group contingencies by Skinner and vicarious reinforcement or imitation by Bandura.

Slavin (1996) cites one intervention that uses cooperative goal structure as the group contingency, in which group rewards are given on the basis of group members' behaviour. The theory underlying group contingencies require that group members be able to actually help one another or work together. The fact that their outcomes are dependent on one another's behaviour, is enough to motivate students to engage in behaviour which helps the group to be rewarded, because the group incentive induces students to encourage goal-directed behaviors among their group mates.
The other behaviorist concept is that individuals who observe someone else getting reinforced for a particular behaviour tend to exhibit that behaviour more frequently themselves-known as vicarious reinforcement (Bandura, 1965). This phenomenon induces that students learn not only by being reinforced themselves, but also seeing other people receive rewards or punishment. Cooperative learning, especially when students are heterogeneously grouped according to motivation and past achievement, offers many opportunities for students to be motivated for hard work from models who are rewarded for their efforts. However, Slavin (1987) believes that extrinsic motivation is preferable over intrinsic motivation. He argues that students receive about 900 hours of instruction every year. It is unrealistic to expect that intrinsic interest and internal motivation will keep them enthusiastically working day out. Evidently, motivational theorists have built group rewards into their cooperative learning methods.

The theoretical rationale for these group rewards is that if students value the success of the group, they will help and encourage one another to achieve much in contrast to the situation in the traditional, competitive classroom (Slavin, 1996).

2.4.2 Social Cohesion Perspectives
Another theoretical perspective, somewhat related to the motivational viewpoint, holds the view that the effects of cooperative learning on achievement are strongly mediated by the cohesiveness of the group, in essence that students will help one another because they care about one another and want to succeed. This perspective is similar to the motivational perspective in that it emphasizes primarily motivational rather than cognitive explanations for the instructional effectiveness of cooperative learning. However, motivational theorists hold that students help
their group-mates learn at least in part because it is in their own interest to do so. Social theorist, in contrast emphasize the idea that students help their group-mates learn because they care about the group (Slavin, 1996). Johnson and Johnson (1999) discuss this perspective with reference to social interdependence theory. One of the cooperative elements that has to be structured in the classroom is positive interdependence or cooperation. When this is done, cooperation results in promotive interaction as group members encourage and ease each other’s efforts to learn. Slavin (1996) “if the task is challenging and interesting, and if students deficiently prepared for skills in groups process, students will experience the process of group work itself as highly rewarding, never grade or evaluate students on their individual contributions to the groups product” Johnson and Johnson (1999).

2.4.3 Cognitive Perspectives
Cognitive psychology, in contrast to motivational and social views, focuses on how humans take in, store and process information to learn. Coginitivists try to look inside the mind to explore how their thinking and learning take place. According to Slavin (1989) cognitive perspective holds that interaction among students will in themselves increase student’s achievement for reasons which have to do with mental processing of information rather than with motivations. Cooperative methods developed by cognitive theorists involve neither the group goals that are the cornerstone of the motivation list methods nor the emphasis on group cohesiveness, the characteristic of social cohesion methods. However, cognitive perspectives can be described in the following two parallel tracks.

2.4.4 Developmental perspectives
The cognitive developmental perspective is grounded in the work of Jean Piaget and Lev Vygotsky. Piagetian perspectives suggest that when individuals work together, socio-cognitive
conflict occurs and creates cognitive disequilibrium that stimulates perspective-talking ability and reasoning. Vygotsky’s theories present knowledge as a societal product (Johnson and Johnson, 1999). Vygotsky (1978) defines the zone of proximal development as “the Distance between the actual developmental level as determined by independent problem solving under Adult guidance or in collaboration with more capable peers”. Bransford et al (2000) narrated the connection between cooperative learning and Vygotsky’s social interaction theory with reference to the concept ‘the zone of proximal development (ZPD)”. They say that the firm collaboration with more capable peers is only possible in cooperative learning.

Similarly Hartman (1997) discusses the bearing of Piaget’s concept of “assimilation and accommodation” with cooperative learning. Assimilation is the incorporation of new information into an existing schema. It involves guided exploration with physical objects in which students can make prediction and confront misconceptions by activating prior knowledge; and accommodation, changing the existing schema or creating a new one to fit new information. For these both processes, a cooperative learning group provides the best opportunity to occur rather than traditional instruction. Moreover, he adds that the “Learning cycle” is a student centered teaching method which was developed from Piaget’s stage theory, and can be implemented via the cooperative learning approach.

Damon (1984) proposed a theoretical model by integrating piaget’s and Vygostky’s perspectives on peer collaboration, which explains why cooperative learning, improve students achievement. This model suggests that the group discussions that occur during cooperative learning achieve the following:
They expose inadequate or inappropriate reasoning, which results in disequilibrium that can lead to better understanding.

They motivate individuals to abandon misconceptions and search for more powerful concepts.

They provide a forum that encourages critical thinking. They lead to constructive controversy, which focuses student’s thinking and increases the use of higher order cognitive processes. They encourage students to vocalize ideas, which inevitably improve their performance. Group discovery methods such as groups of four (Burns, 1981) are the practical cooperative learning methods closely related to the developmental perspectives. Due to little evidence about cooperative methods, which depend solely on interaction to produce higher achievement, Slavin (1995) refers concepts of developmental perspective important as mediating variables to explain the effects of group goals and group tasks on students achievement.

2.4.5 Cognitive elaboration perspectives

The cognitive elaboration perspective identified by O’Donnel (1994) assume that elaboration provides for rehearsal and cognitive restructuring which produce and enhance learning. This perspective emphasizes the role of elaboration to explain the effect of cooperative learning. Elaboration involves the addition of new information to, or restricting of existing knowledge. One of the most effective ways of elaboration is explaining the subject matter to someone else. Research on helping behavior in small groups work shows students to clearly learn more from providing elaborated help to others and less from the receipt of help when the explanation they receive contains some form of elaboration. (Webb 1999) discovered that the students who gained the most from cooperative activities were those who provided elaborated explanations to others. The Students who received elaborated explanations learned more that those who worked alone
but not as much as those who served as explainers. King (1999) found a correlation between the
types of questions asked by students and nature of answers that they receive with higher – order
questions leading to high level answers (King et al. 1998). Asking thought –provoking questions
promotes high level discussion, which has been found to result in high level learning. That is, the
question triggers elaborated explanation, which can positively influence the performance of both
the student providing the help and the student, receiving the help (King, 1999).

With reference to cooperative learning, the student interaction associated with a basic element
face-to-face promotive interaction drives one or more cognitive process. Notable among these is
elaboration-putting material into one’s own words. Elaboration provided by one student to
another is a win/win situation. Elaboration not only deepens the understanding of the student
providing the explanation (Mcleachie, 1999).

Cuseo (1996) adds that the humanistic theorists stress the casual link between conversation and
thinking being product of verbal interaction. Conversation characterized by diversity of
perspectives results in rich, deeper, more comprehensive and more complex thinking. In the field
of cooperative learning, cooperative integrated reading and composition writing/language arts
program (Stevens et al.1987) and reciprocal teaching (Paliscar and Brown, 1984) are the
examples of practical use of the cognitive elaboration potential. All the four perspectives of
cooperation learning have sound rationale and empirical support for their probity. However, each
perspective requires a set of favourable conditions for its implications. For example, according to
Slavin (1996) motivational and social cohesion effects require extrinsic and intrinsic motivation
along with long time social interaction in the classroom to appear, while developmental and
cognitive elaboration perspectives require short time interaction in pairs or groups. In essence these perspectives are complementary, not contradictory. When cooperative groups are seen under motivational perspective, no one can deny the perspective of social cohesion, developmental or cognitive elaboration at the same time. Same is true for each perspective.

2.5 Rationale for Cooperative Learning

Cooperative Learning is strongly advocated in the classroom. The researcher has argued that the superiority and effectiveness of cooperative learning over competitive and individualistic learning on different grounds. Reports on studies comparing the achievement of high-middle and low achieving students in competitive, individualistic and cooperative learning situations show that cooperative learning experiences tend to produce higher results. This is true for “all ages, subject areas, and for tasks involving concept attainment, verbal problem solving, categorization, spatial problem solving, retention and memory and correcting tasks, cooperation seems to be equally as effective as competitive and individualistic learning procedures” (Johnson et al. 1986)

Slavin (1996) points out that numerous research studies in K-12 classroom, in very diverse school setting and across a wide range of content areas, have revealed that students completion of cooperative learning group tasks tend to have higher academic test scores, higher self-esteem, greater numbers of positive social skills, fewer stereo types of individuals of other races or ethnic group, and greater comprehension of the content and skills they are studying.

Cooperative learning is seen as, “a powerful tool to motivate learning and has a positive effect on the classroom climate which leads to encourage greater achievement, to foster positive
attitudes and higher self-esteem, to develop collaborative skills and to promote greater social support, (Ministry of Education, 1997).

### 2.6 Uniqueness of Cooperative Learning

Some people take for cooperative learning as group learning. Actually cooperative learning is not just grouping learning but it is more than group learning. Ellis and Whalen (1990) differentiated the two techniques. Their comments reflect the difference between cooperative learning and small group learning as under:-

#### Table 2.1: Uniqueness of cooperative learning.

<table>
<thead>
<tr>
<th>Cooperative group</th>
<th>Small Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive interdependence. Students sink of swim together. Face-to-face oral interaction</td>
<td>No interdependence. Students work on their own, often or occasionally checking their answers with other students.</td>
</tr>
<tr>
<td>Individual accountability: each pupil must master the material</td>
<td>Hitchhiking: some students let others do most or all of the work, then copy.</td>
</tr>
<tr>
<td>Teachers teach social skills needed for successful group work.</td>
<td>Social skills are not systematically taught</td>
</tr>
<tr>
<td>Teachers monitors student’s behavior</td>
<td>Teachers do not directly observe behavior, often works with a few students or works on other tasks (Grade papers, prepare next lesson etc).</td>
</tr>
<tr>
<td>Feedback and discussion of students’ behavior is an integral part of ending the activity before moving on.</td>
<td>No discussion of how well students worked together, other than general comments such as “Nice Job” or “next time, tries to work more quietly.”</td>
</tr>
</tbody>
</table>
2.7 Disadvantages of Cooperative Learning

Slavin (1996) identified the following pitfalls related to cooperative learning:

**Free Rider:** If not properly constructed, cooperative learning methods can allow for the "free rider" effect, in which some group members do all or most of the work (and learning) while others go along for the ride. The free-rider effect is most likely to occur when the group has a single task, as they are asked to hand in a single report, complete a single worksheet, and produce one project.

**Diffusion of Responsibility:** Diffusion of responsibility is a situation in which students who are perceived to be less skilful are ignored by other group members.

For example, if a group's assignment is to solve a complex math problem, the ideas or contributions of the students believed to be poor at math could be ignored or brushed off, and there is little incentive for the more active participants in the problem-solving activity to take time to explain what they are doing to the less active group members.

**Learning a part of task specialization:** When each group member is made responsible for a unique part of the group's task, as in Jigsaw, Group Investigation and related methods, there is danger that students may learn a great deal about the portion of the task they worked on themselves but not about the rest of the content. However, these dangers are automatically controlled in some methods of cooperative learning.

2.8 Implementation of Cooperative Learning in the Classroom

**Student Teams- Achievement Divisions (STAD)**

According to the Slavin (1996), STAD has been used in every imaginable subject, from mathematics to language, arts to social studies and science, has been used from grade two through college. It is most appropriate for teaching well-defined objectives, such as mathematical
computations and applications, language usage and mechanics, geography and map skills, and science concepts. STAD is a general method of organizing the classroom rather than comprehensive method of teaching any particular subject, teachers use their own lessons and other materials. STAD is one of the simplest of all cooperative learning methods, and is a good model to begin with for teachers who are new to the cooperative approach. Slavin (1995) described the implementation of STAD in the following steps.

2.8.1 Class Presentations
Material in STAD is initially introduced in class presentation. This is most often direct, introduction or a lecture-discussion conducted by the teacher, but could include audio-visual presentations. Class Presentations in STAD differ from usual teaching only in that they must be clearly focused on the STAD unit. In this way, students realize they must pay careful attention during the class presentation, because doing so will help them do well on the quizzes, and their quiz scores determine their team scores.

2.8.2 Learning Teams
Teams are composed of four or five students who represent a cross-section of the class in terms of academic performance, sex and race or ethnicity. The major function of the team is to make sure that all team members are learning and more specifically to prepare its members to do well on the quizzes. After the teacher presents of the material, the team meets study worksheets or other material. Most often, study involves students discussing problems together, comparing answers, and correcting any misconceptions if teammates make mistakes.
The team is most important feature of STAD. At every point, emphasis is placed on team members doing their best for the team, and on the team doing its best to help its members. The team provides the peer support for academic performance that is important for learning and it provides the mutual concern and respect that they are important for such outcomes as inter group relations, self-esteem and acceptance of mainstreamed students.

2.8.3 Individual Quizzes

After approximately one to two periods of teacher’s presentation and one to two periods of the practice, students take individual quizzes. Thus, every student is individually responsible for knowing the material.

2.8.4 Individual Improvement Scores

The idea behind the individual improvement scores is to give each student a performance goal that can be attained if he she workers harder and performs better then me in the past. Any student can contribute maximum points to his or her team in this scoring system, but no student can do so without doing his or her best work. Each student is given a “base” score, derived from the student’s average performance on similar quizzes. Student then earn points for their teams based on the degree to which their quiz scores exceed their base scores.

2.8.5 Team Recognition

Team may earn certificates or other rewards if their average scores exceed a certain criterion. Students’ team scores may also be used to determine up to 20 percent of their grades.

2.8.6 Materials

STAD can use with curriculum materials specifically designed for the Student Team Learning and distributed by the Johns Hopkins Team Learning Project or it can be used with materials
adapted from textbooks or other published sources or with teacher made materials. However, it is quite easy to make your own materials. Simply make a worksheet, a worksheet answers sheet, and a quiz for each unit you plan to teach. Each unit should occupy three to five days of instruction.

2.8.7 Assigning Students to Team.
As we have seen, STAD teams represent a cross-section of the class. You may take likes, dislikes, and “deadly combinations” of students into account in assigning students to teams, but do not let students choose their own, because they will tend to choose others like themselves. Instead, follow these steps:

2.8.8 Team Building
Before starting any cooperative learning program, it is good idea to start off with one or more team-building exercises just to give team members a chance to do something fun and to get to know one another. For examples, teams might be given a chance to create a team logo, banner, song, or rap.

2.8.9 Schedule of Activities
STAD consists of a regular cycle of instructional activities, as follows:

Teach. Present the lesson.

Team study- Students work on work sheets in their teams to master the material.

Test- Students take individual quizzes

Team’s recognition- Team scores are computed based on team members’ improvement scores, and individual certificates, a class newsletter, or a bulletin board recognize high-scoring teams.
2.8.10 Mathematics and Cooperative Learning

Today, knowledge of mathematics is one of the components that separate people who have choices from people without choices. The computer revolution has made math a more integral part of insurance industry, medical research, government, transportation, manufacturing, and construction. Computer programs are used in the clothing industry for creating different sized patterns. Mathematical models of traffic patterns are used to plan road construction. Mathematical illiteracy leads to muddled personal decisions and misinformed government policies. Children born today will enter a work force where knowledge of mathematics is crucial to their career opportunities, their participation in the society, and the conduct of their private lives. Any person who does not have a broad understanding of mathematics will have limited careers opportunities.

Thus, mathematics has been part and parcel of curriculum up to secondary level. Johnson and Johnson (1991) revealed that the goal of mathematics education is to ensure that all students posses a suitable and sufficient mathematics background to become productive citizens in a society that is characterized by complex information and technology. Students must understand math well enough, for example to comprehend society issues such as environmental protection, nuclear energy, defense spending, medical advances, space exploration, and taxation. They must understand math well enough to have the knowledge and skills required to work in modern production facilities. And they must understand well enough to solve problems within a variety of career, societal, and personal contexts.

They query "how this goal can be well accomplished?" has been the focus of researchers for centuries. In USA and some other advanced countries, cooperative learning is well researched for instructional strategy to promote learning in any subject area.
According to Johnson and Johnson (1991) there is considerable evidence indicating that the goals of mathematics instruction will be better achieved when cooperative learning procedures and strategies are employed. The use of cooperative learning will result in students being more cognitively active, more successful in problem solving, more confident in their math abilities, less anxious about learning math, more motivated to take further courses, and better able to transfer what they know about math to career situations.

Researchers, in their research finding of cooperative learning about mathematics achievement, have discussed why students using cooperative learning improve their learning situations. According to Slavin (1987) all forms of cooperative learning focus on involving students to work together to complete their goals.

Robertson et al. (1999) presented a rationale i.e. why does cooperative learning deserve a central place in mathematics instruction? The study of mathematics is often viewed as an isolated and an individualistic effort to solve assigned problems. Perhaps it is not surprising that many students and adults are afraid of mathematics and develop maths avoidance and maths anxiety. They often believe that only a few talented individuals can function successfully in the mathematics realm. Small-group cooperative learning addresses these problems in several ways.
CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The purpose of the study was to examine the effect of cooperative learning on academic achievement of secondary school students in mathematics. In order to test the relative effectiveness of the independent variable i.e. instructional method (cooperative learning), it was important for the researcher to make a choice of the most suitable design for this experiment as a basic step.

3.2 Research Design

Quasi-experimental research involving the Solomon’s four non-equivalent Control Group Design was used. This is because there was non-random selection of students to the groups. Secondary Schools classes exist as intact groups and school authorities do not normally allow the classes to be dismantled and reconstituted for research purposes. (Borg & Gall, 1989; Fraenkel & Wallen, 2001). This design has advantages over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook & Campbell, 1979). The conditions under which the instruments were administered were kept as similar as possible across the school in order to control instrumentation and selection.

The schools were randomly assigned to the control and treatment groups to control for selection, maturation and interaction. Following is a symbolic representation of the design.
Figure 3.1: Solomon Four Non-Equivalent Control group Research Design. Source: Fraenkel and Wallen (2000)

01 and 03 were pre-tests: 02, 04, 05 & 06 were the post-tests: X was the treatment where students were taught using cooperative learning approach. ⊘ Indicates no treatment. Group 1 was the experimental group which received the pre-test, the treatment and the post-test. Group 2 was the control group which received a pre-test followed by the control condition and then a post-test. Group 3 received the treatment X and post-test but did not receive the pre-test. Group 4 received the post-test only since it was a control group. Group 1 and 3 were taught using cooperative learning approach while group 2 and 4 were taught using regular teaching approach.

3.3 Location of study
This study was carried out in Kangema District, Murang’a County – Kenya. It neighbours Kahuro and Mathioya district in the Murang’a North Region. The district is mainly rural and the district headquarters is in Kangema town.
3.4 **Target Population**

The target population for the study consisted of 7780 students from all the 26 public secondary schools in Kangema sub-county (statistics from sub-county education office, Kangema 2011). Nineteen schools are mixed, five are boys schools while two are girls schools. The mathematics teachers in the sub-county are 52. These formed the target population.

3.5 **Sampling procedures**

The unit of sampling was the secondary school rather than individual learners because secondary school operates as intact groups (Borg & Gall, 1989). Each school was considered as one group. The list of the co-educational schools in the district was the sampling frame. The researcher visited the schools to ascertain that they were suitable for research. The researcher ascertained information on the qualification of the teachers that were involved in the study, the class composition and learner’s characteristics. Purposive sampling technique was used to select the four schools that formed the sample of the study. The four schools were randomly assigned to the treatment and control groups. For schools that had more than one form two stream, all the streams were taught using similar method because of ethical reasons and then simple random sampling was used to pick one stream for the study.

3.6 **Sample Size**

The sample comprised four secondary schools. This is approximately 15% of the target population of the public schools in Kangema sub-county. Ary et al (1972:71) observes that in descriptive research, 10-20% of the total population is acceptable. The sample of four selected co-educational school in the division was obtained.
Group 1 (Experimental group)-34 Students
Group 2 (Control group)-31 Students
Group 3 (Experimental group)-33 students
Group 4 (Control group)-30 Students
These were the actual class sizes of the form two classes that were involved in the study.
Schools. The total number of students used in the study was 128.

3.7 Research Instruments

The study employed five (5) instruments namely:

Mathematics teacher questionnaire; Students attitude towards cooperative learning, Questionnaire, (Pre-project survey). Mathematics Achievement Test (post-test) and a students attitude towards cooperative learning Questionnaire (post-project survey).

Mathematics teacher Questionnaire

The study involved trained and experienced mathematics teachers. The questionnaire comprised of six items. This enabled the research to purposively select the schools that were involved in the study (schools with trained experienced teachers and classes with not less than 30 students) Fraenkel and Wallen (2000) recommends at least 30 subjects per group.

ii. Students attitude towards cooperative learning Questionnaire.

This instrument was adopted from a questionnaire which is part of a study being conducted by the centre for the study of learning and performance. “Students Attitudes Towards Group environment” (SAGE) (Concordia university in montreal, Quebec, Canada). It consisted of 11 items assessing students attitudes towards small group learning. The students answered using a Three-point Likert scale with lower answers indicating a more positive attitude towards
cooperative learning. The instrument was used as a pre-project survey and post project- survey for the experimental groups. Results were analyzed by referring to the percentage changes of the responses before and after the experiment.

iii. Mathematics Achievement Test (pre-test)

This consisted of eight (8) items borrowed from past K.C.S E. examinations on the topic of evaluation of numerical expressions using logarithms. It was used as pre-test for the first experimental group (group 1) and first control group (group 2)

iv. Mathematics Achievement Test (post-test)

This instrument was similar to the pre-test, it was administered to the four groups in the study after the experiment.

3.8 Pilot study

The instruments were pilot tested using a different school in the sub county but with similar characteristics as the sample school. This checked on the appropriateness of the data collection instruments and estimated the total time required by the respondents.

3.8.1 Validity

Content and construct validity of the research tools were initiated at the design stage. The validity of an instrument is the extent to which the instrument measures what it is supposed to measure. Items for the MAT were adapted from past K.N.E.C examinations. This strengthened both the content and construct validity.

3.8.2 Reliability

The coefficient of reliability for the attitude questionnaire and the Mathematics Achievement Test was determined through the use of Cronbach Alpha formula and the SPSS package.
The following is Cronbach's alpha formula

\[
\text{Reliability} = \frac{n}{n-1} \left[ \frac{\text{Total variance} - \text{Sum of variance for each question}}{\text{Total variance}} \right]
\]

\[
\alpha = \frac{n}{n-1} \left(1 - \frac{\sum v_i}{v_{\text{test}}} \right)
\]

Where

- \(n\) = number of questions
- \(V_i\) = variance of scores on each question
- \(V_{\text{test}}\) = total variance of overall scores on the entire test
- \(V_i = p_i \times (1-p_i)\)
- \(P_i\) = % of class who answers correctly.

The reliability coefficient was found to be 0.81 and 0.86 respectively for the attitude Questionnaire and the MAT. both were above the critical value of 0.70.(Streiner, 2003)

### 3.9 Data collection

On the first day of the research, students in the experimental groups were asked to complete a pre-project survey (Appendix A). This was to assess the students attitude towards cooperative learning before the start of the experiment. The content that was used in the class instructions was developed based on the revised KIE 2002 mathematics syllabus. A guiding manual was available for the teachers who were involved in administering cooperative learning approach that was used throughout the treatment period. The teachers of the experimental groups were trained
by the researcher on how to use the manual. The teachers using cooperative learning approach taught for one week using the cooperative learning method on a different topic other than the one used for the study to enable them master the skills. After this period the pre-test was administered to group 1 and group 2. The experimental groups were taught using cooperative learning method while those in the control groups were taught using the RTM method on the topic of Evaluation of numerical expressions using logarithms. Treatment period was three weeks as recommended in the syllabus (KIE) 2002 for the coverage of the topic. At the end of treatment period a post-test was administered to all the groups. At the end of the experiment, student in the experimental groups once again completed the attitude Questionnaire (Appendix D). This was to assess how the attitude towards cooperative learning had changed in the course of the experiment. The researcher scored both the pre-test and post-test and generated quantitative data was analyzed.

3.10 Data analysis

All the collected data was assembled for marking, coding and analysis. Using a pre-prepared marking scheme, the achievement test was marked by the researcher and scores were entered on a score sheet. These marks were then converted into percentages for comparative analysis. Several strategies were used to analyze the data.

A descriptive analysis of the general impression of the study involved frequency distributions, measures of central tendency and measures of dispersion. Class means were used to analyze the relationships of the independent variable and the dependent variable. Analysis of variance (ANOVA) was used to give information on within and between the group variations of the post-test scores. It was used to determine whether the initial differences were significant. A t-test was
used when dealing with the means because of its superior power to detect differences between two means. Significance level of 0.05 was used to test the null hypothesis.

3.11 Logical and ethical considerations

The procedure that was used to collect data ensured that existing policies for data collection from schools were followed. A research permit was obtained from the National Council For Science and Technology. With this together with a letter of introduction from the University, consent to conduct research was obtained from District Education Office. using the endorsed documents, permission to visit schools was sought from the principals in all the sampled schools. The principals introduced the researcher to the mathematics Heads of departments in each of the involved schools who in turn introduced the researcher to the mathematics teachers. The nature and purpose of the study was explained to the teachers before participation in data collection. The researcher reassured the participants that the data was meant for research purposes only.

3.12 Conclusion

This chapter described the research design, locale, sample size and sampling techniques, research instruments and administration of the instruments. It also described the reliability and validity of the research instruments and the ethical considerations for the study. The next chapter describes the methods of data analysis, presentation, interpretation and discussion of the research findings.
CHAPTER FOUR

REPORTING AND DISCUSSION OF THE FINDINGS

4.1 Introduction

The purpose of the study was to assess the effects of cooperative learning on student’s achievement in mathematics and also to assess the student’s attitude towards cooperative learning before and after the treatment. This presents the results of the study and a discussion of the findings.

4.2 Data analysis presentation and interpretation

The mode of date collection was by a mathematics teacher’s questionnaire, student’s questionnaires before and after treatment and pretest before the experiment and a post test after the treatment.

The t-test, ANOVA, Levine and Scheffe’s statistical methods were used to analyze the data.

4.3 Response Rate

Table 4.1 Response Rate

<table>
<thead>
<tr>
<th>Instrument category</th>
<th>Frequency</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers Questionnaire</td>
<td>26</td>
<td>26</td>
<td>100</td>
</tr>
<tr>
<td>Students Questionnaire</td>
<td>67</td>
<td>67</td>
<td>100</td>
</tr>
<tr>
<td>Pretest</td>
<td>65</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>Post test</td>
<td>128</td>
<td>128</td>
<td>100</td>
</tr>
</tbody>
</table>
Data on Table 4.1 Indicates that the research was successful in that 26(100%) of the teachers respondent filled and returned the questionnaire. 67(100%) students (in both experiment groups filled and returned the students questionnaire before and after treatment. 65 students sat for the pretest and 128 students (100%) sat for the post-test.

### 4.4 Academic qualification of the mathematics teachers

The study sought to establish the academic qualifications of the mathematics teachers. The results are shown in the table 4.2.

**Table 4.2 Academic qualification of the teachers**

<table>
<thead>
<tr>
<th>Academic Qualifications</th>
<th>Number of Teacher</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of education</td>
<td>12</td>
<td>46.2</td>
</tr>
<tr>
<td>Diploma</td>
<td>5</td>
<td>19.2</td>
</tr>
<tr>
<td>BSC/PGDE</td>
<td>4</td>
<td>15.4</td>
</tr>
<tr>
<td>Master of Education</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td>Untrained/graduate</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td>BA/PGDE</td>
<td>1</td>
<td>3.8</td>
</tr>
</tbody>
</table>

In the 26 schools in the district a teacher per school teaching a form 2 class was selected to fill the teacher's questionnaire. The main objective of this questionnaire was to find out on the qualification of the teachers, experience and the number of students in the classes. As shown in table 4.2 (46.2%) of the selected teachers had Bachelor of education 5(19.2%) were diploma holders 4(15.4%) had degrees with PGDE, 2(7.7%) has master of education 2(7.7%) were untrained graduates while 1(3.8%) had a bachelors of art with PGDE.
4.4.1 Years of service in teaching mathematics

Previous studies have suggested that teachers with more years of teaching experience tend to perform better than those with less years of experience.

Similarly Awiti (2006) argues that good academic results are realized in schools where teachers know the subject, teach the pupils by participating in classroom management as they apply teaching methodology.

The study sought to establish the years the teachers had taught mathematics. The data in table 4.3 shows the length of time the teachers had taught.

<table>
<thead>
<tr>
<th>Table 4.3: Teaching experience of the mathematics teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching experience</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>2-6 years</td>
</tr>
<tr>
<td>6-12 years</td>
</tr>
<tr>
<td>12-18 years</td>
</tr>
<tr>
<td>Above 18 years</td>
</tr>
</tbody>
</table>

Source: Mathematics Teachers Questionnaires

Table 4.3 shows that 4(15.3%) teachers had a teaching experience of 2-6 years 10(38.5%) had a teaching experience of 6-12 years 8(30.8%) had taught mathematics for 12-18 years while 4 had been teaching mathematics for over 18 years.

Based on the above findings the researcher purposively selected four schools where the teacher was qualified (trained with at least a diploma in education), 6 years and above of teaching mathematics and a class of not less that 30 students.
Frankel and Wallen (2000) recommend at least 30 subjects per group. Each of the 4 selected schools was considered as a group. The researcher therefore ended up with the following four groups each with a qualified teacher.

<table>
<thead>
<tr>
<th>Group</th>
<th>Type of Group</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>(experimental group)</td>
<td>34</td>
</tr>
<tr>
<td>Group 2</td>
<td>(control group)</td>
<td>31</td>
</tr>
<tr>
<td>Group 3</td>
<td>(experimental group)</td>
<td>33</td>
</tr>
<tr>
<td>Group 4</td>
<td>(control group)</td>
<td>30</td>
</tr>
</tbody>
</table>

4.5 Academic achievements of students in mathematics

The first study objective sought to determine whether the cooperative learning method is more effective than the regular methods of teaching mathematics. To collect data on the academic achievement, a pre-test was administered to group 1 (first experimental group) and group 2 (first control group). Both experimental groups (group 1 and group 3) were exposed to the treatment condition (cooperative learning) for a period of three weeks. Group 2 and group 4 (control groups) were taught using the regular methods of teaching mathematics over the same period after which a post-test was administered to the four groups. Results are shown in appendix 4. Interpretation of the results is as follows:
Table 4.4 - Pre-test mean scores on cooperative learning and t-value results

<table>
<thead>
<tr>
<th>Learning Methods</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>T-value</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>34</td>
<td>19.06</td>
<td>16.89</td>
<td>64</td>
<td>0.096</td>
<td>0.446</td>
</tr>
<tr>
<td>Control</td>
<td>32</td>
<td>18.64</td>
<td>19.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4 shows the mean scored by experimental and control group. The difference between mean scored by the two groups was not statistically significant at $\alpha = 0.05$ significant level using T-value. It also shows that sign of 0.446 was greater than 0.05, an indication that the groups were homogeneous and thus suitable for the study.

4.6 Effects of the cooperative learning Strategy on the Students’ Achievement

The results presented in table 4.5 shows the student’s mean gain after use of the cooperative learning method. The mean gain is the difference between the pre-test and the post-test score of the same group. The data indicate that the experimental group has a mean gain of 35.12 and control group a mean gain of 2.52. The mean gain of the experimental group is higher than that of control group. The t-value shows also that there is significant difference between the mean score of the two groups. The difference can be attributed to the use of cooperation method strategy.
Table 4.5 Effects of cooperative learning.

<table>
<thead>
<tr>
<th>Learning Method</th>
<th>N</th>
<th>Pre-test mean</th>
<th>Post-test mean</th>
<th>mean gain</th>
<th>Df</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental 1</td>
<td>34</td>
<td>19.06</td>
<td>54.18</td>
<td>35.12</td>
<td>63</td>
<td>4.406</td>
<td>0.000</td>
</tr>
<tr>
<td>Control 1</td>
<td>32</td>
<td>18.64</td>
<td>21.16</td>
<td>2.52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results presented in the Table above indicates that the posttest mean scores of the experimental groups (1 and 2) are higher than the posttest mean scores of the control groups (1 and 2). This is attributable to application of cooperative teaching strategy to experimental groups.

Table 4.6 Students post–test mean scores

<table>
<thead>
<tr>
<th>Learning Methods</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1</td>
<td>34</td>
<td>54.18</td>
<td>25.890</td>
<td>4.440</td>
</tr>
<tr>
<td>Control 1</td>
<td>31</td>
<td>21.16</td>
<td>23.774</td>
<td>4.270</td>
</tr>
<tr>
<td>Experiment 2</td>
<td>33</td>
<td>46.39</td>
<td>22.539</td>
<td>3.923</td>
</tr>
<tr>
<td>Control 2</td>
<td>30</td>
<td>22.47</td>
<td>15.498</td>
<td>2.830</td>
</tr>
<tr>
<td>Total</td>
<td>128</td>
<td>39.31</td>
<td>25.169</td>
<td>2.225</td>
</tr>
</tbody>
</table>
A further analysis using one-way ANOVA test shown in Table 4.7 indicated that there is a statistically significant difference between the mean scores of the experimental groups and that of the control groups ($\alpha < 0.05$).

Table 4.7 – Anova Results

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>18152.504</td>
<td>3</td>
<td>6050.835</td>
<td>12.044</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>62296.996</td>
<td>124</td>
<td>502.395</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>80449.500</td>
<td>127</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To test for the homogeneity of the groups, the Levine test was carried out.

Table 4.8—Test of Homogeneity of Variances

<table>
<thead>
<tr>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.056</td>
<td>3</td>
<td>124</td>
<td>.009</td>
</tr>
</tbody>
</table>
The table 4.8 was to test for homogeneity and Levine test indicated that the groups were homogeneous. This allowed for the suitability of the study hence the decision that the cooperative method was effective.

To show which pairs of groups had significant mean score differences, Scheffe’s method of Post HOC tests of multiple comparisons was carried out yielding the results presented in Table 4.9. The results in Table revealed that there is a statistically significant difference in mean scores between the experimental groups and control groups. The results also indicated that there is no statistically significant mean score difference between the two experimental groups or the two control groups. That is, the mean difference between Experiment1 and Control1 and Experiment2 and Control2, was statistically significant (P < 0.05). But the mean difference between Experiment 1 and Experiment 2 (P = 0.570) and Control 1 and Control 2 (P= 0.996) was not statistically significant.
Table 4.9 Post Hoc Comparisons of the cooperative post Test Scores for the Four Groups

<table>
<thead>
<tr>
<th>Factors</th>
<th>(J)</th>
<th>Mean difference (1-J)</th>
<th>Std Error</th>
<th>Sig</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower bound</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Upper bound</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>-26.273*</td>
<td>5.566</td>
<td>.000</td>
<td>-42.05</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-18.491*</td>
<td>5.606</td>
<td>.051</td>
<td>-34.38</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.437</td>
<td>5.740</td>
<td>.995</td>
<td>-14.83</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>26.273*</td>
<td>5.566</td>
<td>.000</td>
<td>10.50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7.783</td>
<td>5.477</td>
<td>-7.74</td>
<td>23.31</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>27.710</td>
<td>5.615</td>
<td>11.80</td>
<td>43.62</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>18.491*</td>
<td>5.606</td>
<td>.015</td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-7.783</td>
<td>5.477</td>
<td>.570</td>
<td>-23.31</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>19.927</td>
<td>5.654</td>
<td>.008</td>
<td>3.90</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>-1.437</td>
<td>5.740</td>
<td>.996</td>
<td>-17.71</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-27.710*</td>
<td>5.615</td>
<td>.000</td>
<td>-43.62</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-19.927*</td>
<td>5.654</td>
<td>.008</td>
<td>35.95</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 levels

FACTORS

1 Control 1
2 experiment 1
3 experiment 2
4 control 2
4.7 Students attitudes towards cooperative learning

In order to find out how the student’s altitudes changed after cooperatively leaning together in small groups, on the first day of research, students in the experimental groups were asked to complete a pre-project survey (see appendix A) on the second day; the students were placed in groups assigned by the teacher based on their previous curriculum assessment scores. Following the completion of the treatment, students in the experimental groups were asked to complete a post-project survey (see appendix D) which was similar to the pre-project survey. Below is the data related to the findings?
<table>
<thead>
<tr>
<th>Items</th>
<th>Variables</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No %</td>
<td>No %</td>
<td>No %</td>
</tr>
<tr>
<td>1.</td>
<td>I like to work in groups in a maths class</td>
<td>36 55</td>
<td>5 8</td>
<td>24 37</td>
</tr>
<tr>
<td>2.</td>
<td>I ask others questions when I work in a group</td>
<td>20 31</td>
<td>2 30</td>
<td>43 66</td>
</tr>
<tr>
<td>3.</td>
<td>Others in the group ask me questions when we work in groups</td>
<td>25 38</td>
<td>6 10</td>
<td>34 52</td>
</tr>
<tr>
<td>4.</td>
<td>I have more confidence to try problems when I work in a group</td>
<td>33 51</td>
<td>10 15</td>
<td>22 34</td>
</tr>
<tr>
<td>5.</td>
<td>Working in a group helps me understand the concept better</td>
<td>31 48</td>
<td>3 4</td>
<td>31 48</td>
</tr>
<tr>
<td>6.</td>
<td>Working in group helps get the work completed on time</td>
<td>21 33</td>
<td>0 0</td>
<td>44 67</td>
</tr>
<tr>
<td>7.</td>
<td>Working in groups helps me to learn quicker and retain more for the tests</td>
<td>35 54</td>
<td>7 11</td>
<td>23 35</td>
</tr>
<tr>
<td>8.</td>
<td>When I work in a small group everyone is encouraged to contribute</td>
<td>37 57</td>
<td>6 9</td>
<td>22 34</td>
</tr>
<tr>
<td>9.</td>
<td>When I work in a small group ideas and opinions are treated with respect</td>
<td>34 52</td>
<td>5 8</td>
<td>26 40</td>
</tr>
<tr>
<td>10.</td>
<td>I am comfortable asking the teacher questions if I don’t understand something</td>
<td>25 38</td>
<td>4 7</td>
<td>36 55</td>
</tr>
<tr>
<td>11.</td>
<td>I am comfortable asking a group member questions if I don’t understand something</td>
<td>38 58</td>
<td>3 5</td>
<td>24 37</td>
</tr>
</tbody>
</table>
I like to work in groups in a maths class

2. I ask others questions when I work in a group

3. Others in the group ask me questions when we work in groups

4. I have more confidence to try problems when I work in a group

5. Working in a group helps me understand the concept better

6. Working in group helps get the work completed on time

7. Working in groups helps me to learn quicker and retain more for the tests

8. When I work in a small group everyone is encouraged to contribute

9. When I work in a small group ideas and opinions are treated with respect

10. I am comfortable asking the teacher questions if I don't understand something

11. I am comfortable asking a group member questions if I don't understand something
Table 4.11 Shows the responses of the students in the experimental groups on attitudes towards cooperative learning after treatment.

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>Variable</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>1.</td>
<td>I like to work in groups in a math’s class</td>
<td>51</td>
<td>78</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>I ask others questions when I work in a group</td>
<td>40</td>
<td>62</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Others in the group ask me questions when we work in groups.</td>
<td>28</td>
<td>43</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>I have more confidence to try problem when I work in a group.</td>
<td>45</td>
<td>69</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Working in a group helps me understand the concept better</td>
<td>48</td>
<td>74</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>Working in group helps get the work completed on time</td>
<td>23</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>Working in groups helps me to learn quicker and retain more for the texts.</td>
<td>47</td>
<td>72</td>
<td>6</td>
</tr>
<tr>
<td>8.</td>
<td>When I work in a small group everyone is encourage to contribute</td>
<td>56</td>
<td>86</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>When I work in a small group ideas and opinions are treated with respect</td>
<td>51</td>
<td>78</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>I am comfortable asking the teacher questions if I don’t understand something</td>
<td>32</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>I am comfortable asking a group member</td>
<td>48</td>
<td>74</td>
<td>4</td>
</tr>
</tbody>
</table>
The second study objective sought to examine the student’s attitudes towards cooperative learning groups prior and after being exposed to it. The following were the findings. The study involved 65 students who were exposed to cooperative learning strategy. On the statement “I like to work in groups in a mathematics class” before the experiment 36 (55%) (table 4.10) agreed while 24 (37%) (table 4.10) disagreed. After the study 51 (78%) (table 4.11) agreed to liking working in groups in a math’s class while those who disagreed had dropped to 9 (14%) (table 4.11). It is therefore clear that the student’s attitude towards cooperative learning had significantly changed on the positive. This agrees with Kirby’s study on an action research of cooperative learning had positively imparted on their learning experience (Kirby 2007 p. 76) on
the statement “I ask others questions when I work in a group” 20(31%) (table 4.10) agreed while 43(66%) (Table 4.10) disagreed. After the implementation of cooperative learning the number of those who agreed rose to 40(62%) (Table 4.11) while those who disagreed decreased to 24(37%) (Table 4.11) on the statement “others in the group ask me questions when work in a group”. Prior to the experiment 25(38%) (Table 4.10) disagreed. After cooperatively learning 28(43%) (table 4.10) disagreed. The willingness to ask and answer questions from group’s members had increased although minimal. The results agree with the findings of Stahl (1995) who noted that cooperative learning encourages students to interact, ask and answer questions, solve problems and make decisions. The percentage of the students who were comfortable asking the teachers question if they don’t understand something also increased from 25(38%) to 32(49%). Cooperative learning helps teachers create a positive effective classroom atmosphere in which psychological barriers such as students anxiety are lowered while self-confidence and self-esteem are increased (Crandall 1999; Dornyei, 1997; Oxford 1997).

On the statement “I have more confidence to try problems when I work in a group” before the experiment 33(51%) (table 4.10) agreed while 22(34%) (table 4.10) disagreed however after being exposed to cooperative learning 45(69%) (table 4.11) agreed while only 12(18%) (table 4.11) disagreed. The number of those who agreed increased significantly. Crandall (1999) states that students anxiety results from making mistakes especially when they are asked a question to be answered individually. When students are allowed to study together they have more time to think, to share their opinion with others, receive feedback from them and correct any mistakes. This often results in enhanced self confidence and self-esteem. On the statement “working in a group helps me understand the concept better” initially 31 (48%) agreed while 31 (48%) disagreed. After learning through cooperative small groups 48 (78%) agreed while 14 (22%)
disagreed. Therefore more students agreed to their understanding of concept being enhanced by cooperative learning. On the statement “working in groups helps me learn quicker and retain more for the test” before the experiment 34 (54%) agreed. This changed to 47 (72%) after exposure to cooperative learning. This agrees with Kirby’s study who concluded that: there was an improvement in the minimum and maximum scores of students. Students believed that cooperative learning allowed for a more relaxing environment where they exhibited better understanding. (Kirby 2007)

On the statement “when I work in a group everyone is encouraged to contribute” initially 37 (57%) agreed while 22 (34%) disagreed. And on the statement “when I work in small group ideas and opinions are treated with respect,” before the treatment 34 (52%) agreed while 26 (40%) disagreed after treatment 51 (78%) agreed while 14 (22%) disagreed

In both statements the percentages had increased to the positive. Kagan and Kagan (1994) have shown that students acquire social skills with cooperative learning. They state that when cooperative learning is used students learn to understand, respect and support one another. Other studies in the field have shown that cooperative learning improves students’ self-esteem, enables them to establish positive interpersonal relationships and posters positive interdependence. (Johnson & Johnson, 1992). On the statement “working in groups helps get the work completed on time” initially 21 (33%) agreed while 44 (67%) disagreed. After treatment 23 (35%) agreed while 40 (60%) disagreed. These shows that majority of the students felt that with cooperative learning assignment are not completed on time. Slavin (1995) identified a few disadvantages related to cooperative learning.
Free rider: - cooperative learning methods can allow for the "free rider" effect, in which some group members do all or most of the work (and learning) while others go along for the ride. This effect is most likely to occur when the group has a single task, as they are asked to hand in a single report, complete a single worksheet, or produce one project. When the free riders are asked for individual assignments or projects during individual evaluations, they will have difficulties completing the work.

Diffusion of responsibility: - students who are perceived to be less skillful are ignored by other group members. For example, in a group assignment to solve a complex math problem, the ideas or contributions of such students believed to be poor at math could be ignored or brush off. Such students end up with little incentive for them to participate and end up with little lea or no learning at all. Such students will take more time on assignments. However with proper construction of the groups and effective monitoring by the teacher the above dangers can be reduced or avoided.
CHAPTER FIVE.

SUMMARY, CONCLUSION AND RECOMMENDATIONS.

5.1 Introduction
This chapter presents a summary of the main study findings together with conclusions and recommendations. The chapter also offers suggestions for further research.

5.2 Summaries of the main findings of the study.
The study sought to assess how cooperative learning as a teaching strategy affects the academic achievement of learners. The study also sought to answer the question related to how the student’s attitudes towards cooperative learning will change during the treatment period. Main findings have been presented according to the study objectives.
The first study objectives sought to examine how cooperative learning method of teaching will affect the academic achievement of the learners as compared to the traditional method of teaching and learning.

i. The pre-test means were close to each other because the groups were randomly assigned. On the post-test, both treatment groups out scored both controls.

ii. There appears to be no difference between the treatment groups even though one got a pretest and the other did not.

iii. Similarly the two groups scored about the same on the post test, thus the pre-test did not appear to affect the outcome, but both treatment groups clearly outscored both controls. There is main effect for the treatment.

Students taught mathematics through the cooperative learning strategy performed significantly better than those who were taught through the Regular Teaching methods.

These findings support earlier studies that concluded that the use of the cooperative
learning strategy improved achievement scores compared to traditional teaching methods (Hanze & Berger, 2007). Cooperative learning enhances social interactions which is essential to meet the needs of students and maintains trust among them (Slavin, Leavy & Madden, 1989). Students assisted one another in the learning process and it was the duty of each group member to make sure that the other group member had mastered the concepts learnt.

However, students need sufficient time to develop the confidence and social skills necessary for effective participation in a cooperative – learning class (Johnson and Johnson, 1990). Slavin (1990) cautions teachers who believe students can simply be placed in groups, given interesting materials or problems to solve and allowed to discover information or skills. Successful cooperative learning should always include direct instruction because cooperative activities supplement, but do not replace, direct instruction. However, they involve individual accountability because group success depends on member’s contribution to a team task. This study was done with these issues in mind and the results show that the use of cooperative learning method leads to better achievement than the conventional methods.

iv. On the second study objective, on attitude change, students indicated that they felt more confident in their ability to do mathematics. Many of those attributed this to the interactions in their groups. The student frequently stated that helping others and gaining ideas from their classmates improved their understanding of the material. Social interactions are seen as a critical part of knowledge construction because that is where constructions take place.
Koehler & Grouws (1992) advocated this when they said that students should not be passive absorbers of Information, but rather have an active part of acquiring knowledge. The findings of this research showed an improvement in student’s attitudes towards cooperatively learning together in small groups.

5.3 Conclusion

Based on the findings of this study which was carried out in Kangema sub-county of Murang’a county – Kenya, it was concluded that students who are taught Mathematics using cooperative learning strategy performed better than those taught by use of traditional teaching methods. The study found an increase in student attitudes after working in cooperative learning groups. Gullies (2004) suggests that there is much to be gained by encouraging the use of this non-traditional pedagogical approach to teaching in classrooms, particularly when schools are trying to encourage the development of positive attitudes towards learning, prosocial behaviours among students and successful learning outcomes for students. Students believed that group tasks clear concepts more than individual learning. It also makes learning interesting it provides fun, done in satisfactory situation and their socialization is enhanced.

Cooperative learning has many positive effects in the mathematics classroom. If it is properly implemented, Studies have found that if teachers have some kind of group reward system with provisions for individual accountability, cooperative learning can be successful. Teachers must also prepare students to work cooperatively by emphasizing the need for good listening skills and openness to their ideas of others. An effective use of cooperative learning in the class room can positively affect student’s social skills, self-esteem and intergroup relationship which will lead to better academic achievement in mathematics.
5.4 Recommendations

Based on the findings of the study the researcher recommends:

i. Teachers should continuously monitor the work of not only the group but also individual members and identify those students who try to become irresponsible from the task.

ii. The teacher should use cooperative learning approach side by side with other individual learning approaches because cooperative learning strategy does not replace direct instructions but supplements other teaching approaches.

iii. Cooperative learning strategy is incorporated in teacher education programs and the in-service courses for mathematics teachers.

5.5 Suggestions for further research

i. This study only lasted for three weeks. However, attitude is something very abstract and subjective in detecting changes in the short term. Therefore the research should take a longer time span so that the results of this study can be validated.

ii. The study should be extended to other areas of study including sciences and languages for a generalized conclusion about the effectiveness of cooperative learning technique as a method of teaching.

iii. Similar tests should be administered in future to measure the level of retention of the material learnt in the past.

iv. The research was confined to co-education schools. Further research is suggested to include same gender institutions.
REFERENCES


Hartman, A. (1978) GENOGRAMS. Ann Arbor Mc, the University of Michigan, School of social Work 1978.


SAGE(Students Attitudes Towards Group Environment)-

Sapon Shavin, & Schniedewind (1990): Knowledge and teaching Harvard Education Review.


SMASSE Project (Phase 1) 1998: Project Documentation for 2nd Phase of SMASSE Project JICA.


Susand,s.Ellis & Susan, F.Whallen(1990).*Research in Cooperative Learning*.


APPENDICES

APPENDIX A: STUDENT PRE PROJECT SURVEY

Please give your honest response to each statement.

<table>
<thead>
<tr>
<th></th>
<th>I like to work in groups in Math's class</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like to work in groups in Math's class</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>2</td>
<td>I ask others questions when I work in a group</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>3</td>
<td>Others in the group ask me questions when we work in groups</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>4</td>
<td>I have more confidence to try problems when I work in a group</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>5</td>
<td>Working in a group helps me understand the concepts better</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>6</td>
<td>Working in a group helps get the work completed on time</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>7</td>
<td>Working in groups helps me to learn quicker and retain more for the tests.</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>8</td>
<td>When I work in a small group, everyone is encouraged to contribute</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>9</td>
<td>When I work in a small group, idea and opinions are treated with respect.</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td></td>
<td>Question</td>
<td>Agree</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>10</td>
<td>I am comfortable asking the teacher questions if I don't understand something.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I am comfortable asking a group member questions if I don't understand something.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B: PRE-TEST

1. Use logarithm to evaluate: $\sqrt[3]{(35.6 \times 0.0613^2)}$ (4 Marks) (1989 PP1 No. 1)

2. Use mathematical tables to evaluate: $\sqrt{\frac{1.935 \times 0.0765}{32.74}}$ (3 Marks) (1991 PP2 No. 1)

Give your answer to three significant figures.

3. Use mathematical tables to evaluate: $\sqrt{0.00452}$ (3 Marks) (1993 PP1 No. 2)

4. Use logarithms to evaluate: $(0.07284)^2$ (4 Marks) (1995 No. 1)

5. Use logarithms to evaluate: $(1934)^2 \times \sqrt{0.00324}$ (3 Marks) (1997 PP1 No. 1)

6. Use logarithms to evaluate: $\log_5 (0.79 \times 0.3511^2)$ (4 Marks) (1999 PP2 No. 1)

7. Use logarithms tables to evaluate: $\frac{334.7 \times 0.4666}{\sqrt[3]{0.0924}}$ (4 Marks) (1997 PP1 No. 1)

8. In this question, show all the steps in your calculations, giving your answer at each stage. Use logarithms, correct to 4 decimal places, to evaluate:

$\sqrt{\frac{36.72 \times (0.46)^2}{185.4}}$ (4 Marks) (2006 PP2 No. 1)
APPENDIX C: POST-TEST

1. Evaluate: \[
\frac{1.34}{(5.24)^{0.8} \times 0.0029}
\] (4 Marks)

(1990 PP2 No. 1)

2. Use logarithms to evaluate: \[
\frac{7.08}{\sqrt{7.68 \times 7.034}}
\] (4 Marks)

3. Use logarithms to evaluate: \[
\sqrt{\frac{4.662 \times 0.038}{0.62}}
\] (4 Marks)

(1994 PP1 No. 1)

4. Use logarithms to evaluate: \[
\sqrt{\frac{36.15 \times 0.02573}{1.936}}
\] (3 Marks)

(1996 PP1 No. 1)

5. Use logarithms to evaluate: \[
55.9 + (0.2621 \times 0.01177)^{\frac{1}{2}}
\] (4 Marks)

(1998 PP2 No. 1)

6. Use logarithms to evaluate: \[
\sqrt{\frac{1.23 \times 0.0069}{76.54}}
\] (4 Marks)

(2001 PP1 No. 3)

7. Use logarithms to evaluate: \[
(3.256 \times 0.0536)^{\frac{1}{3}}
\] (4 Marks)

8. Use logarithms to evaluate: \[
\frac{(0.0063)^{\frac{1}{3}}}{1.38 \times 27.42}
\] (3 Marks)

(2002 PP2 No. 1)
APPENDIX D: STUDENT POST-PROJECT SURVEY

Please give your honest response to each statement.

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like to work in groups in Math's class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I ask others questions when I work in a group</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>3</td>
<td>Others in the group ask me questions when we work in groups</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>4</td>
<td>I have more confidence to try problems when I work in a group</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>5</td>
<td>Working in a group helps me understand the concepts better</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>6</td>
<td>Working in a group helps get the work completed on time</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>7</td>
<td>Working in groups helps me to learn quicker and retain more for the tests</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>8</td>
<td>When I work in a small group everyone is encouraged to contribute</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>9</td>
<td>When I work in small group ideas and opinions are treated with respect</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>10</td>
<td>I am comfortable asking the teacher questions if I don’t understand something</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>11</td>
<td>I am comfortable asking a group member questions if I don’t understand something</td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
</tbody>
</table>
APPENDIX E – TEACHERS MANUAL FOR CONDUCTING COOPERATIVE LEARNING

Classroom organization

Group size/composition

Size to be appropriate to the assigned task

Group composition to be heterogeneous.

Room arrangement/materials

- Desks and chairs arranged so that all group members can see and hear one another.

- Ensure adequate space for each group member.

- Ensure materials for the lesson are appropriate, available and easily accessible.

Classroom management

Establishment of clear guidelines that facilitate positive interdependence and promote group harmony.

It should be made clear that everyone should contribute, listen with care to others, encourage others to participate and ask for help or clarification.

Establish and consistently enforce a set of rules and procedures that govern the handling of routine administrative procedures, students oral participation, and movement during different types of activities.

Ensure smooth transitions occur which should culminate in students being ready to begin and finish work on their assigned task(s).
On use of time – the teacher must promptly start relevant administrative procedures such as roll call and begin instruction or provide directions for group work. The teacher should keep students/groups actively involved in appropriate instructional tasks during the whole lesson.

**Presentation of content**

Motivation – the teacher should identify for the students the importance and usefulness of the objective outlined at the beginning of the lesson. Ensure the students discover what the topic is about, why it is interesting to them and what they already know about the topic.

Input

Provide instructional examples text books etc. Ensure students discuss ideas in a language familiar to their peers. Explain relevant material and skills to the class. Ensure students check one another for understanding of concepts and skills and provide review when necessary.

**Group facilitation**

Cohesiveness – students should show mutual respect for those of other races, ethnic origins and social classes. Encourage students to work productively in their groups and reinforce (praise, reward) students who engage in appropriate behaviour.
Ensure that students are aware that they play a unique role on the team and that the team could not succeed without them.

Clear role expectations – assign roles such as reader recorder calculator, checker, reporter, time keeper, encourages of participation and checker for understanding.

Accountability – students should be held accountable for individual learning through testing, individual work or structuring activities so that each student is responsible for a specific part of the group product.

**Monitoring**

Intervening – teacher should monitor group progress and intervene when serious problems hamper group or individual learning.

Notes progress/problems – make one of individual/group accomplishments, how progress is being made toward goal attainment and how problems are being resolved.

Provide task assistance by clarifying, re-teaching or elaboration.

Re-teach/discussion – use notes from monitoring and students/group input to identify areas that need re-teaching or further discussion. If problems or incorrect answers are discovered use this opportunity to re-teach or discuss the correct answer or solution with the group.

**Lesson summary**

Process/product effectiveness. At the conclusion of the group activity/project, the student and the teacher should evaluate the progress made by the group (social and academic) and evaluate learning’s (products/outcomes) from the students work.
APPENDIX F: MATHEMATICS TEACHERS QUESTIONNAIRE

Instructions

This is not a test.

You are kindly requested to answer all the questions honestly

The information you provide will be kept confidential.

Please respond by putting a tick (✓) for the information required in each item and where necessary provide the additional information as may be requested.

Part I

Category of the school

Boy  Day ( )  Boarding ( )

Girls Day ( )  Boarding ( )

Mixed Day ( )  Boarding ( )

Your Gender  Female ( )  Male ( )

Academic Qualifications

Diploma ( )  BED ( )  BSC ( )

BSC/PGDE ( )  MED ( )
Others please (specify) ____________________________________________

Number of years teaching mathematics

<table>
<thead>
<tr>
<th>Years</th>
<th>( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2</td>
<td></td>
</tr>
<tr>
<td>2 - 6</td>
<td></td>
</tr>
<tr>
<td>6 - 12</td>
<td></td>
</tr>
<tr>
<td>12 - 18</td>
<td></td>
</tr>
<tr>
<td>Above 18</td>
<td></td>
</tr>
</tbody>
</table>

Have you trained in marking KCSE mathematics

<table>
<thead>
<tr>
<th>Option</th>
<th>( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

If yes for how many years have you been marking? ____________________________________________

How many students do you have in your form two class? ______________________________
### APPENDIX G: RESULTS OF THE PRE-TEST AND THE POST-TEST SCORES

#### Group 1

<table>
<thead>
<tr>
<th>SERIAL NO</th>
<th>Pre-test X/30</th>
<th>Pre-test %</th>
<th>Post-test X/30</th>
<th>Post-test %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>60</td>
<td>25</td>
<td>83</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>30</td>
<td>17</td>
<td>57</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>10</td>
<td>22</td>
<td>73</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>3</td>
<td>22</td>
<td>73</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>53</td>
<td>25</td>
<td>83</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>3</td>
<td>22</td>
<td>73</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>30</td>
<td>29</td>
<td>97</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
<td>50</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>10</td>
<td>28</td>
<td>93</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>33</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>10</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>11</td>
<td>37</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>7</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>7</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>20</td>
<td>9</td>
<td>30</td>
<td>22</td>
<td>73</td>
</tr>
<tr>
<td>21</td>
<td>5</td>
<td>17</td>
<td>28</td>
<td>93</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>23</td>
<td>6</td>
<td>20</td>
<td>22</td>
<td>73</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>13</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>3</td>
<td>20</td>
<td>67</td>
</tr>
<tr>
<td>26</td>
<td>9</td>
<td>30</td>
<td>27</td>
<td>90</td>
</tr>
<tr>
<td>27</td>
<td>11</td>
<td>37</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>28</td>
<td>11</td>
<td>37</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>29</td>
<td>11</td>
<td>37</td>
<td>26</td>
<td>87</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
<td>33</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td>3</td>
<td>10</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>3</td>
<td>21</td>
<td>70</td>
</tr>
<tr>
<td>33</td>
<td>1</td>
<td>3</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>34</td>
<td>2</td>
<td>7</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>SERIAL NO</td>
<td>Pre-test X/30 %</td>
<td>Post-test X/30 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>-----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 3</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1 3</td>
<td>1 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15 50</td>
<td>24 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2 7</td>
<td>9 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1 3</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2 7</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1 3</td>
<td>2 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>18 60</td>
<td>16 53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>7 23</td>
<td>6 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11 37</td>
<td>7 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>13 43</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1 3</td>
<td>6 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>6 20</td>
<td>9 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>3 10</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1 3</td>
<td>7 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>3 10</td>
<td>9 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>11 37</td>
<td>3 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>3 10</td>
<td>11 37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>1 3</td>
<td>6 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>9 30</td>
<td>24 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>1 3</td>
<td>3 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>2 7</td>
<td>6 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>7 23</td>
<td>11 37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>1 3</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1 3</td>
<td>1 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>10 33</td>
<td>18 60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>22 73</td>
<td>24 80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>16 53</td>
<td>11 37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>11 37</td>
<td>12 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>11 37</td>
<td>14 47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>4 13</td>
<td>13 43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Group 3

<table>
<thead>
<tr>
<th>SERIAL NO</th>
<th>X/30</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>70</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
<td>27</td>
</tr>
<tr>
<td>8</td>
<td>24</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>67</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>12</td>
<td>26</td>
<td>87</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>14</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>18</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>19</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
<td>80</td>
</tr>
<tr>
<td>21</td>
<td>26</td>
<td>87</td>
</tr>
<tr>
<td>22</td>
<td>19</td>
<td>63</td>
</tr>
<tr>
<td>23</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>24</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>25</td>
<td>19</td>
<td>63</td>
</tr>
<tr>
<td>26</td>
<td>24</td>
<td>80</td>
</tr>
<tr>
<td>27</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>28</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>32</td>
<td>19</td>
<td>63</td>
</tr>
<tr>
<td>33</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>SERIAL NO</td>
<td>X/30</td>
<td>%</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>----</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>15</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>16</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>14</td>
<td>47</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>21</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>22</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>23</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>24</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>25</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>26</td>
<td>20</td>
<td>67</td>
</tr>
<tr>
<td>27</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>28</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>29</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>30</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>
APPENDIX I: AUTHORITY LETTER

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Address: P.O. Box 38442-00100
Website: www.ncst.go.ke

Republic of Kenya

To: NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Gentleman,

Patrick Mwangi Kamau
Kenyatta University
P.O. Box 43444-00100
Nairobi.

Subject: RE: RESEARCH AUTHORIZATION

I am pleased to inform you that you have been authorized to undertake research in Kangema District for a period ending 31st December, 2013.

You are advised to report to the District Commissioner and District Education Officer, Kangema District before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

Said Hussein
FOR: SECRETARY/CEO

Copy to:
The District Commissioner
The District Education Officer
Kangema District.

APPENDIX II: AUTHORITY LETTER

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Address: P.O. Box 38442-00100
Website: www.ncst.go.ke

Republic of Kenya

To: NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Gentleman,

Patrick Mwangi Kamau
Kenyatta University
P.O. Box 43444-00100
Nairobi.

Subject: RE: RESEARCH AUTHORIZATION

I am pleased to inform you that you have been authorized to undertake research in Kangema District for a period ending 31st December, 2013.

You are advised to report to the District Commissioner and District Education Officer, Kangema District before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

Said Hussein
FOR: SECRETARY/CEO

Copy to:
The District Commissioner
The District Education Officer
Kangema District.
Patrick Mwangi Kamau
Kenyatta University
P.O. BOX 43844-00100,
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “Effects of cooperative learning approach on academic achievement of secondary school students in Mathematics in Kangema, Murang’a County, Kenya for a period ending 31st December, 2013, you have been authorized to undertake research in Secondary Schools in Kangema District.

On completion of the research, you are expected to submit one soft copy and a hard copy to this office.

District Education Officer
KANGEMA
A locale map of Murang'a County.