Over time educators have often indicated that the critical responsibility carried out by the home and family environment determines the academic success of the child. The earlier parental involvement begins therefore, the more effective it becomes. While research indicates that parental involvement in children homework has many benefits like improving children’s academic achievement, fostering school–home feedback, fostering learners’ initiative, cultivating parental responsibility, as well as increasing learner’s skill, there is evidence that parental involvement in homework is low internationally and nationally. Locally, studies have not given much attention to the level of parental involvement in children’s homework mainly at the lower primary school level which forms part of ECDE. This study therefore will seek to identify the ways in which parents get involved in their lower primary pupils’ homework. It will also explore the factors that might influence this involvement including, parental occupation, educational level and parental gender although there exists other factors that influence parental involvement in homework. The study will target parents from public schools in the sub county. Two schools out of 43 schools will be sampled and twenty parents purposively selected to form the study sample. The study will be guided by Joyce Epstein’s theory of overlapping spheres of influence which recounts that most effective families and schools work have common characteristics. The study will adopt an exploratory approach using a descriptive survey design to gather information from parents. The aim of this research is to make recommendations for the formation of effective programs on parental involvement in homework of their ECDE children suited to Kenyan public primary schools so that pupils, teachers and parents will derive the greatest benefits from the study. The study will adopt qualitative approach methodology and use interview schedules as data collecting instruments. Data will be analyzed using descriptive statistics such as frequencies, mean, variances and standard deviation and the findings will be presented by use of graphs and tables and pie charts.
ABSTRACT

Over the years poor performance has consistently been observed in geometry. Geometry has an important place in primary school mathematics curricula. This study aimed at establishing the influence of practical approach on achievement in geometry in public primary schools in Thogoto zone, Kiambu County. The main objectives of the study determined the extent which mathematics teachers use the practical method. The study also established resources used, effects and errors and also investigated teachers and pupils’ attitudes towards geometry. This study was carried out in public primary schools in Thogoto educational zone, Kiambu County. The zone had twelve public primary schools with total population of 1035 pupils and 24 mathematics teachers. In this study one school was used for piloting and four other schools were used for the main study. Quasi experimental research and cluster sampling method were used. Four schools were randomly sampled from four clusters making up the zone. Three hundred and forty three pupils and eight teachers were randomly sampled from four schools sampled. Geometry standard tests and questionnaires were used to obtain data. Standard seven mathematics syllabuses content on geometry were analyzed to form ten questions. Geometry standard tests were administered to all standard seven pupils before and after teaching. Teaching and learning methodology data, gathered using teachers and pupils questionnaires. Data analyzed using excel and statistical package for social sciences (SPSS version 2.0).
Frequency tables, graphs and pie charts were used. Findings showed that mathematics teachers within Thogoto zone used variety of methods while teaching geometry. There was general consensus among teachers that use of teaching/learning resources improved teaching. T-Test analysis showed significant effect on performance when using practical approach. The critical value at $p < 0.05$ using 2-tailed t-table i.e. $p (T > b) = \alpha/2$ with degree of freedom (df) = 298, $b$ was 1.960 where $\alpha$ was infinity. The critical value at 10% significance level was 1.282, which was 10% in each lower and upper tail. The critical value at 5% significance level was 2.326 and 2.576 at 1% significance level. Findings indicated four conclusions. First, use of practical method in teaching geometry was very low, secondly, practical teaching was more effective method of teaching than other classroom teaching methods, thirdly, geometrical concepts that relates to shapes were easily understood by pupils and lastly, teachers and pupils had both positive and negative attitudes towards geometry teaching. The study recommended that, ministry of education should target to incorporate practical teaching of geometry in primary schools through SMASE program, emphasizing on improvisation of teaching and learning resources, organizing in-service training on syllabus interpretation and applications of practical approach in teaching, focusing on enhancing teachers understanding on practical teaching and improving creativity and attitude change in geometry teaching and learning.
CHAPTER ONE
INTRODUCTION

1.0 Preamble

This chapter focuses on the study background, highlighting the context of the study. It also outlines the research problem, objectives, hypothesis, research questions, significance, scope and limitations, assumptions and theoretical and conceptual framework that guides the process of the this study.

1.1 Background to the study

In the modern world, geometry is a crucial branch of mathematics, both as a prerequisite knowledge to many other areas of mathematics and real life activities. Understanding of geometric concepts and relationships is vital to the study of other branches of mathematics. Mugo and Kisui (2010) reaffirm that geometry strengthens one’s ability to visualize, analyze and solve problems. Knowledge in geometry is essential for interpreting, understanding and appreciating our world in which examples of geometry abound. Geometry is a very important area in architecture. The world is looking for workers who can design and construct safe buildings, bridges and roads to minimize dangers and accidents. In addition, standard eight graduates can be self employed in the informal industrial sector by constructing domestic items such as simple cookers, solar panels and other containers. Pupils who have a good grasp of geometry concepts have better chances of joining good secondary schools as they perform better in national exams. Mastery of geometry concepts can enable them to contribute to their country’s economic, social and political development. In spite of the crucial role played by good
mastery of geometric concepts, many primary school pupils do not seem to be well grounded in basic geometry upon leaving primary school (SMASE, 2011).

According to SMASE primary baseline survey carried out by CEMASTEA, geometry is one of the most problematic areas in the teaching and learning of mathematics in primary schools (SMASE, 2011). Geometry has an important place in school mathematics curricula as it develops pupils’ spatial ability, logical reasoning skills and ability to solve real world problems in which geometrical terminologies and properties occur (French, 2004, Presmeg, 2006).

Every year thousands of Kenyan pupils sit for the Kenyan certificate of primary education examination (KCPE). Over the years poor performance by KCPE candidates has consistently been observed in geometry items. In the year 2000, out of five most failed questions in the republic, one was a geometrical question testing construction of a perpendicular line from a point to a line. Similarly, in 2010, one of the poorly performed KCPE questions was a geometry question. The question tested the concept of angles formed by parallel lines (KCPE Report, 2000 & 2010).

A survey conducted by teaching practice committee of Thogoto TTC indicated that 60% of topics given to practising teacher trainees by mathematics teachers in public primary schools included geometry and algebra (appendix I pg107). A survey conducted by one mathematics subject head disclosed geometry as one of the most difficult topics to teach among the teacher trainees as it was indicated by 78% of respondents (appendix II pg108). Table 1.1 represents part of the findings as given by teacher trainees.
<table>
<thead>
<tr>
<th>Serial no</th>
<th>Teaching topics</th>
<th>Very hard to teach</th>
<th>Hard to teach</th>
<th>Easy to teach</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Geometry</td>
<td>78%</td>
<td>21%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Sources: - Teaching practice committee records, 2012.

What factors contribute to this situation? Many factors can be attributed to this problem, some of which are the way concepts are taught, teaching / learning resources are used, whether or not the pupil’s environment is supportive enough and examination issues.

This study therefore investigated influence of practical approach of teaching on achievement in geometry in public primary schools in Thogoto zone. Teaching geometry concepts practically provides learners with meaningful activities designed to help them comprehend geometric concepts and visualize geometric figures. Practical activities reinforce and extend the ideas and skills taught in class enhancing the learning experiences of the learners. Selected practical activities depend on syllabus specific objectives and content and therefore the mathematics teacher needs proper planning (SMASE, 2011).

When considering activities for learners, it is advisable to start from simple activities to more challenging ones. Effective teaching takes into account the prerequisite knowledge/skills of the learners before giving the activity. Since learners’ abilities vary, practical approach to geometry teaching ensures that learners interact with different activities which in turn lead to their intellectual development. Learners retain more of
what they learn by doing than through hearing (Miano, 2008). The practical approach is learner centered where the teacher facilitates learning.

In teaching and learning of mathematics in primary schools, it is important that the teachers remain focused on what they intend to achieve by the end of eight years in primary school. In order to achieve lesson objectives of primary mathematics and by extension the national goals of education, it is important that teachers use appropriate teaching approaches. There are two main teaching strategies namely expository and heuristic.

(a) **Expository strategy:** largely directs instructions from the teacher telling the learner. Learners passively listen and take notes. The teacher becomes the centre of nearly all the activities in the classroom.

(b) **Heuristic strategy:** This is learner centered as the learner is at the centre of most learning activities. The teacher takes the role of a facilitator providing suitable resources to ensure that the learner achieves the set objectives.

In addition, effective teaching of content depends on choice and usage of appropriate learning resources (KIE, 2006).

In Kenya, Kenya institute of Education (KIE), currently referred to as Kenya Institute of Curriculum Development (KICD), provides primary schools with teaching syllabus. This ensures that teachers in all primary schools teach the same content.

The improvement of quality of teaching and learning of mathematics has been one of the great concerns of the Ministry of Education since mathematics equips the learners with knowledge and skills which assist in developing logical thinking, ability to apply
knowledge required to analyze situations and making rational decisions (Development plan, 1997-2001).

Geometry appears abstract and so learners experience difficulties in conceptualization, seeing relationships and making connections to real life situations (KIE, 2002). At primary school level, mathematics is considered significant in the development of pupils’ cognitive abilities. Out of 40 lessons per week, covering six examinable subjects, mathematics is allocated 7 lessons. Mathematics curriculum at this level is organized such that knowledge and skills learnt at one stage are used as foundation for the next level. Mathematics is a compulsory subject in primary school curriculum. Mathematics curriculum is divided into different topics and subtopics as given in the KIE primary syllabus. Each topic has various broad subject objectives and related content for each class (KIE syllabus, 2002).

The ministry of education has duties and responsibility in primary, secondary and teacher education management, curriculum development and curricula literature publishing (Session paper no1.2005). Kenya institute of curriculum development (KICD) is the centre for curriculum development and research previously known as Kenya Institute of Education. This institute was established in 1968 under the Education Act cap 211. Its core function is defined in the KIE legal order of 1976 and lately revised in 2010.

Curriculum is the sum total of school activities within the school and out of school. Its major components include: aims, goals and objectives, content, methods and evaluation. KICD ensures that quality and relevant curriculum and curriculum support materials are developed. KICD uses the panel system in curriculum development that includes subject
panels, course panels and academic committees. Subject panels look at each subject where subject specialists are involved. Each panel initiates and guides appropriate curriculum development projects, research and evaluation activities in the relevant subject. They review all examinations conducted in Kenya such as KCPE mathematics and PTE mathematics papers. The mathematics panel also recommends mathematics books for use in schools and teacher training colleges. Course panel members create greater coordination and harmony in education especially by guiding the activities of subject panels. The KICD syllabus is used in schools and teacher training colleges as teaching syllabuses.

KNEC through its subject panels adopts the KIE syllabus into examination syllabus which is sent to schools to help teachers prepare their pupils for KNEC examinations (MoE, TPC 2011). The teacher training colleges (TTCs) comprising of public and private colleges have the mandate of training teachers in content, methodology and practical teaching in primary schools using KICD teacher training syllabus. Teachers Service Commission (TSC) has the role of deployment of teachers to public educational and training institutions and organization of induction courses (TSC, 2005).

The center for mathematics, science and technology education in Africa (CEMASTEIA) is an in-service education and training (INSET) centre that develops capacity of mathematics and science (MS) teachers. It conducts continuous professional development (CPD) through regular in-service for mathematics and science teachers in order to equip them with sufficient pedagogical skills so as to make them more effective in curriculum implementation (MoE, TPC, 2011).
The teaching of geometry starts from standard one where the learner is expected to recognize and identify straight, curved, rectangular, triangular and circular shapes (KIE syllabus, 2002). This content develops spirally from one level to the other. Geometry as a topic requires the learner to use the geometrical tools and practically learn geometrical concepts. Teachers are expected to prepare schemes of work, lesson plans, and lesson notes and organize geometry teaching/learning activities and resources for effective teaching.

Thogoto Teachers Training College student trainees perform their teaching practice in Kiambu County, where public schools are commonly used. According to 2012, KCPE results, most public schools in this zone had less than 50% mean standard score (appendix III pg109) in mathematics as indicated by table 1.2 below:

**Table 1.2. KCPE 2012 Mathematics performance per school**

<table>
<thead>
<tr>
<th>S/N</th>
<th>SCHOOLS</th>
<th>ENTRY</th>
<th>M.S.S</th>
<th>CLUSTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KKT</td>
<td>87</td>
<td>60.16</td>
<td>Kikuyu</td>
</tr>
<tr>
<td>2</td>
<td>THT</td>
<td>80</td>
<td>40.73</td>
<td>Thogoto</td>
</tr>
<tr>
<td>3</td>
<td>GTB</td>
<td>70</td>
<td>40.02</td>
<td>Kinoo</td>
</tr>
<tr>
<td>4</td>
<td>THR</td>
<td>57</td>
<td>39.32</td>
<td>Thogoto</td>
</tr>
<tr>
<td>5</td>
<td>MSGT</td>
<td>217</td>
<td>63.95</td>
<td>Kikuyu</td>
</tr>
<tr>
<td>6</td>
<td>MAGT</td>
<td>53</td>
<td>43.38</td>
<td>Thogoto</td>
</tr>
<tr>
<td>7</td>
<td>NGR</td>
<td>75</td>
<td>49.42</td>
<td>Kinoo</td>
</tr>
<tr>
<td>8</td>
<td>UTR</td>
<td>102</td>
<td>39.49</td>
<td>Kabete</td>
</tr>
<tr>
<td>9</td>
<td>MANGI</td>
<td>125</td>
<td>51.6</td>
<td>Kinoo</td>
</tr>
<tr>
<td>10</td>
<td>H.G.M</td>
<td>78</td>
<td>44.85</td>
<td>Kabete</td>
</tr>
<tr>
<td></td>
<td>School</td>
<td>Code</td>
<td>Percentage</td>
<td>Cluster</td>
</tr>
<tr>
<td>---</td>
<td>--------</td>
<td>------</td>
<td>------------</td>
<td>---------</td>
</tr>
<tr>
<td>11</td>
<td>RNGR</td>
<td>66</td>
<td>40.98</td>
<td>Kabete</td>
</tr>
<tr>
<td>12</td>
<td>KDFAR</td>
<td>42</td>
<td>63</td>
<td>Kikuyu</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>48.075</td>
<td>4 clusters</td>
</tr>
</tbody>
</table>

**Source:** *Kikuyu district office, Kiambu County - (KCPE 2012 data analysis)*

The low performance in this zone raises major concern on the methods of teaching, syllabus coverage and teachers attitude towards mathematics teaching. This study intended to find out methods used in teaching geometry and influence in student achievement when practical approach of teaching geometry is used against other methods among standard seven pupils in Thogoto Zone, Kiambu County, Kenya.

### 1.2 Statement of the problem

Educators, researchers and scholars have consistently challenged methods used in mathematics teaching in Kenyan schools. Eshiwani, (1984) criticized teachers for using out dated approaches to teaching. He recommended the application of productive methods of teaching as opposed to learning by rote. The method used should not ignore the learner based activities and participation.

Over the years poor performance by KCPE candidates has consistently been observed in geometry items (KCPE report, 2000 & 2010). SMASE primary baseline survey, carried out by CEMASTEA (Centre for Mathematics, Science and Technology Education in Africa) reaffirmed geometry as one of the most problematic areas in teaching and learning in primary mathematics (SMASE, 2011).

The traditional view of teaching has been teacher – centered. In this approach the teacher transmits facts while learners are passive recipients. Current teaching theories dictate the
need for a learner centered approach. In this approach, learners use ideas and materials to construct knowledge. A practical approach is learner-centered. It arouses learner’s curiosity while sustaining interest. It is crucial in developing relevant skills and attitudes (Mugo and Kisui, 2010).

According to SMASE (2011) primary findings, it was noted that teachers did not employ practical work in construction of models, construction of angles, identifying angles and plane figures. Findings indicated that teachers explained how it should happen and not the actual practical work (SMASE, 2011). In the context of this study, 'practical work' refers to tasks in which students observe or manipulate real objects or materials in order to understand key concepts in geometry.

This study sought to determine the influence of the practical approach of teaching geometry on students’ achievement in Thogoto zone. The study compared achievement when using practical approach of teaching with other teaching methods.

1.3 Purpose of the study

SMASE observers in Kiambu County indicated that mathematics lessons largely involved lecture, demonstrations and class discussions. In addition, learning resources like textbooks and geometrical sets were not adequate in some lessons (SMASE, 2013).

KCPE results in most public schools had less than 50% mean standard score in mathematics in Thogoto zone (KCPE, 2012). Similarly geometry questions were identified as the most difficulty in mathematics results (KCPE, 2009 & 2011).
Thogoto teachers’ training college trainee frequently received geometry as a teaching practice topic from mathematics teaching teachers in this zone. The trainee expressed geometry as the most difficulty topic to teach during their teaching practice (appendix i pg 107 and appendix ii pg 108).

This study therefore sought to investigate various methods used by mathematics teachers, specifically using practical approach to assess influence on student’s achievement in geometry. The study further established resources used, teachers and pupil’s attitudes towards geometry in Thogoto zone.

1.4 Objectives of the study

This study sought to achieve the following objectives:

(i) To determine the extent to which primary mathematics teachers use the practical teaching approach in Thogoto zone.

(ii) To establish the resources used in teaching geometry in primary schools in Thogoto zone.

(iii) To establish the effects of practical teaching on performance in geometry in primary schools in Thogoto zone.

(iv) To determine teachers’ and pupils’ attitudes towards geometry in primary schools in Thogoto zone.

1.5 Research hypotheses

H01 There is no statistically significant difference in use of practical approach while teaching geometry in Thogoto zone.
**H02** There is no statistically significant difference in use of resources while teaching geometry in Thogoto zone

**H03** There is no statistically significant difference in effect on student performance in geometry when using practical methods in primary schools in Thogoto zone

**H04** There is no statistically negative or positive attitudes among teachers and pupils towards geometry teaching and learning in primary schools in Thogoto zone.

1.6 **Assumptions of the study**

The basic assumptions that guided this study were:

- All the teachers selected for the study had gone through the same teachers training in terms of teaching skills and methods.
- All teachers selected for the study had no challenges in syllabus interpretation in terms of specific objectives and content in geometry
- All respondents for the study were cooperative and provided reliable responses.

1.7 **Scope and limitations of the study**

This study focused on geometry content from standard seven KIE syllabuses. Twelve activities were covered during practical teaching (appendix v pg111). The content involved lines and angles in geometry. The questions were evaluated using Blooms cognitive domains. The geometry questions tested knowledge, comprehension, application, analysis, synthesis and evaluation. The questions further tested three key aspects, mathematical terms, facts and construction skills.
The ten questions focused on lines and angles based on standard seven syllabus content. Question one, two, seven, nine and ten tested knowledge of parallel lines, triangles, quadrilaterals, space figures and construction of triangles and measuring of length while question three, eight, five, six and seven tested interior and exterior angles, complimentary angles, isosceles triangles, and angles formed on parallel lines. The tests concentrated on mostly tested geometry concepts in KCPE papers however areas least tested were avoided such as construction of angles, nets and pattern making. The questions focused on behaviours and constructive ideas of learners after teaching hence based on constructivism and behaviorism theories.

In this study practical teaching in geometry focused on various standard seven pupils. Concepts were developed logically in order of competence and importance. The researcher inducted mathematics teachers on syllabus interpretation, conceptual development and content expected to be covered within two weeks. In a practical approach in teaching geometry pupils observed, manipulated real objects and materials during teaching and learning.

1.8 Significance of the study
This study would be of beneficial in the following ways:

(i) Improving training methodology in Teacher Training Colleges on effective use of various methods of teaching mathematics in primary schools. This would involve effective use of teaching and learning resources and proper use of environment by mathematics teachers.

(ii) Benefiting future researchers by providing data on which further studies can be done. This would continue building body of knowledge in mathematics.
Kenya institute of curriculum development (KICD) can use the findings in designing course materials suitable in addressing geometry teaching in primary schools.

Teacher can use the findings to improve teaching / learning activities both minds on and hands on, by creating a context for learning in which students can become engaged in interesting activities that encourages and facilitates learning.

1.9 Theoretical frame work

This research was guided by Vygotsky’s (1978) social constructivism theory. A constructivist teacher creates a context for learning in which students can become engaged in interesting activities that encourage and facilitate learning. The teacher does not simply stand by, and watch children explore and discover, instead, he /s he often prepare, guide students and evaluate them as they solve problems in classroom situations. The research relied much on skills attainment and behaviour change during geometry teaching and learning.

Teachers encourage the students to work in groups solving geometry issues and questions. They support students with encouragement and advices as they tackle problems, seek adventures, and challenges that are rooted in real life situations that are both interesting and satisfying in terms of the result of students work. Teachers thus facilitate cognitive growth and learning as do peers and other members of the child's community through teaching and learning. Technology provides essential tools with which to accomplish the goals of a social constructivist classroom. Teaching tools were locally available within the schools environment.
Vygotsky's emphasis on the social origins of cognition, have implications for the teaching of mathematics, as well as for instructional design generally. In Vygotsky's theories both teachers and learners play very important roles in learning. The theory relates well with behaviorism theory of Robert Gagne, (1992) where learners are viewed as passive and therefore need external motivation and reinforcement. This calls for a well structured curriculum that provides the learner with some learning experiences. Geometry concepts are developed in stages from simple to complex. The topics also make use of concrete materials hence learners are assumed to use learned experiences in other levels to learn the content in question. In this study teachers used the practical approach and other methods to allow learners construct meaning and solve geometrical problems.

Teaching / learning resources enhance mental construct of geometrical meaning (Twoli, 2007). Constructivism relates to the behaviorist learning theory of Robert Gagne, (1992). Gagne combined behaviorist principles of learning with cognitive theory of learning to form information processing that focuses on internal processing that occur during a learning moment. The rate of learning increases as learners are less likely to lose time or become frustrated by basing performance on incorrect facts or poorly understood concepts (Quist, 2002). Mathematics teachers should teach geometry concepts effectively, using appropriate geometrical terms. Learning conditions should be taken into account. These conditions include the learner, learning and teaching activities, content and approach used (Ornestein, 1990). In geometry constructivism theory suggests that knowledge acquisition is better done through learner centered approach, hence need for practical method where learners learn by doing.
In this study the practical teaching in geometry concepts focused on various individual pupils from standard seven classes. Teaching considered earlier learned geometry content. Concepts were developed logically in order of competence and importance (appendix V pg111). Learners were motivated to learn new ideas from old simple ideas and every act of teaching provided the child with an opportunity for discovery (Mugo, 2010). Figure 1.1 illustrates that once effective teaching was practised and learners positively motivated they sought interest in other methods and the process continued. Gagnes’, (1992) technological model of a system approach demonstrates this process. This model consists of three basic elements namely input, process and output. The input include the learner who is ignorant of content to be covered at this level; however the learner had some entry behavior in terms of background experience, knowledge, skills, values, attitudes and behaviours (Twoli, 2001). This experience is improved through use of teaching / learning process. The process is the teaching / learning, facilitated by the mathematics teacher. The teacher chooses the teaching methods, resource materials, learning activities and evaluation procedures. The output is an informed person with increased knowledge, highly skilled and with positive attitudes as determined by exams or assessment. In geometry learners are the inputs, they are processed at different levels of teaching and finally coming out as learned individuals in geometry concepts. Desired output can be checked through feedback mechanism such as assessment (Twoli, 2001).
Figure 1.1 Gagne’s technological model of a system approach relating to practical teaching in geometry concepts

The above illustration revealed that if some new knowledge has to be produced a certain process on the original learning experience has to be carried out (Twoli, 2001). In this case of geometry, learners are the inputs that are put in a practical teaching. By 'practical work' this means tasks in which students observe or manipulate real objects or materials or they witness a teacher demonstration.

1.10 Conceptual Frame work

Concepts were developed logically in order of competence and importance through teaching. Learners were motivated to learn new ideas from old ideas and every act of teaching provided the child with an opportunity for discovery (Waweru, 1992). Teaching was based on acquisition of knowledge, skills and attitudes hence cognitism aspect however teaching mainly considered the practical skills and pupils behaviour through interaction with geometry content. Independent variable was practical approach in learning geometry and dependent was performance in geometry.
Experimental group received practical teaching while the control group received teaching by use of other teaching methods on selected geometry activities.

Conceptual framework and theoretical framework are description of the main independent and dependent variables of the study and relationship among them. Independent variables are conditions or characteristics that are manipulated to ascertain the relationship to observe phenomenon. In this study independent variable was geometry learning through practical teaching. Dependent variables are conditions that appear to change as the independent variable changes (Orodho, 2005). In this study dependent variable was performance in geometry among standard seven pupils after teaching. Intervening variables included time allocation, pupils’ attendance during geometry
teaching, effective use of mathematics curriculum and choice of other methods in teaching of geometry and teaching learning materials for geometry teaching.

The conceptual frame work illustrated how some elements interact with each other to cause effective teaching of geometry in standard seven. The use of appropriate practical teaching method, proper preparation and effective teaching in standard seven classes lead to improved performance in geometry. Time allocation for teaching geometry, pupil’s attendance, KICD mathematics syllabus and choice of geometry teaching/ learning materials and teaching methods form the intervening variables in this study that may have affected research finding but not researched on.

1.11 Definition of Key Terms
In the context of this study the terms listed shall be used to mean:

**Demonstration method:** an explanation, illustration or experiment showing how something works.

**Discussion method:** Oral or verbal exchanges of ideas such as debate, review, examine, argue about or exchange views.

**Environment:** external condition or surroundings which influence development of pupil’s behaviour such as home or school.

**Examination:** written exercises set to test a pupil’s knowledge and skill to show achievement.
**Geometry**: a branch of mathematics concerned with the properties, relationships, and measurements of points, lines, curves, and surfaces.

**Lecture method**: a method of teaching by formal discourse by giving verbal instructions.

**Public school**: any school that is part of a free local educational system developed and maintained by public funds.

**Practical approach**: real, applied, actual, hands on, in the field, experimental method rather than in theory.

**Spatial errors**: a mistake or inaccuracy related to space.

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**CHAPTER TWO**

**LITERATURE REVIEW**

**2.0 Introduction**

This chapter reviews the literature related to this study. It focuses on teaching, learning and performance in mathematics in general and geometry in particular. It is subdivided into the following areas: concept of practical teaching, practical learner- centered versus teacher- centered approach, geometry teaching, model and theories of teaching / learning geometry concepts, geometry teaching strategies, effective teaching and assessment on geometry, the concept of geometry, standard seven geometry conceptual development and misconceptions, teaching and learning materials for primary schools geometry.
2.1 Concept of Practical Teaching

By the terms 'practical work', it is implied that students have a chance to observe and manipulate real objects, materials or witness a teacher’s demonstration. Practical activities enhance the pupils’ understanding in addition to sharpening their creative skills (Mugo and Kisui, 2010). An effective teacher plans practical work with specific learning objectives in mind. By using different pedagogical approaches the same practical task can be used to achieve different learning outcomes (KIE, 2012).

Geometry training at primary teachers training colleges is guided by a number of instructional objectives. These include the following: ability to identify activities that lead to recognition of lines, show how to construct lines, identify activities that lead to recognition of angles, show how to measure and construct angles, show how to bisect angles using ruler and pair of compasses, inscribing regular polygon in a circle, circumscribing a circle on triangles and making models of prisms and cones from nets.

Although teaching objectives suggest that geometry teaching is basically practical oriented, SMASE primary baseline survey carried out by CEMASTEA, identified geometry as one of the most problematic areas in teaching and learning in primary schools. Teachers tend to use talk and chalk method rather than organizing practical activities in geometric conceptual development (SMASE, 2011). A practical approach to geometry teaching ensures that learners interact with different activities which in turn lead to the intellectual development of learners. Learners retain more of what they have learnt by doing than what they learn through hearing as some of the practical activities may include group and individual activities, classroom and outdoor projects (Mugo and
Kisui, 2010). This study therefore sought to determine extent to which primary mathematics teachers used practical teaching approach in Thogoto zone.

2.1.1 Practical learner- centered versus teacher- centered approach

The traditional view of teaching has been teacher – centered. On this approach the teacher transmits facts while learners are passive recipients. Current teaching theory is emphasizing the need for a learner centered approach. In this approach learner uses ideas and materials to construct knowledge.

A practical learner centered approach has the following advantages: - learner- centered, arouses curiosity while sustaining the learner’s interest and crucial in developing relevant skills and attitudes.

According to SMASE (2011) primary findings, it was noted that teachers did not employ practical work in construction of models, construction of angles using a ruler and a pair of compasses and also identifying angles and plane figures. An accurate construction can be produced by proper use of the following instruments: a pencil, a ruler, a pair of compasses, a protractor and a set square. The findings indicated that teachers explain how it should happen and not the actual practical work. The learners rarely use the geometrical tools and even lack basic knowledge of these tools. In construction of triangles learners are supposed to use rulers, protractors and pair of compasses. Learners should practically measure the lengths, angles and transfer the same to their drawings by first filling tables for reference. Other practical activities include constructing perpendicular lines, parallel lines, bisecting lines and angles, measuring angles using a protractor, identifying types of angles formed by intersecting lines as well as parallel lines and transversals. on top of these, there is also construction of angles of
90° and 60°, identifying right angled triangle relations, identifying quadrilaterals and recognizing their properties, drawing circles, circumscribing and inscribing polygons in it and constructing nets of space figures (KIE, 2010). Teachers tend to explain and provide chalkboard illustration at the expense of practical actions. For instance the concept of interior angles of a triangle can be practically taught as follows: providing a triangular paper cut out, letting learners label the interior angles, tearing off the corners and lining up together to form a straight line (180°). Learners discover that the angle sum of interiors angles of a triangle form a straight line hence add up to 180°. This can be reinforced by the learner measuring the angles using a protractor to confirm his/her observation. This would provide better conceptual understanding rather than the teacher explain that angle sum of interior angles add up to 180° and illustrating the concept on chalkboard for pupils to copy. Similarly when teaching circumscribing and inscribing, learners can use triangular paper cut outs, fold their sides and angles equally to identify centers of circles required respectively. Right angled triangle relationship can be practically demonstrated by forming squares using square unit on each shorter side of the triangle and then using all square units used to form a square on the longer side (hypotenuse) of the said right angled triangle, discovering that sum of squares of the shorter sides equals the square of the longer side.

SMASE, (2013) lesson observation report showed that out of the 10 lessons observed in Geometry, most were on construction of angles and triangles, while one was on properties of circles. These lessons had very limited use of project method, role play, outdoor activity, discovery or practical approach. This took place in thirteen counties where Kiambu County was among the sampled counties. This study sought to establish
how teachers teach, use teaching/learning resources and plan teaching/learning activities in geometry in this zone.

2.2 Mathematics and geometry teaching

Mathematics teaching is the process by which man transmits his experiences, new findings, and values accumulated over the years in his survival and development through generations. Mathematics enables individuals and society to make an all round participation in the development process by acquiring knowledge, skills and attitudes (SMASE, 2013). In the United States, teachers are assumed to be competent once they have completed their teacher–training programs. Japan makes no such mistake and gives teachers primary responsibility for improvement of classroom practice through lesson observations. In 2013, CEMASTEA organized similar lesson observations in thirteen counties in Kenya. On a continuum between teacher-centered and learner centered lessons, 32% of the methods indicated were largely teacher-centered, while about 21% were tending to a large extent towards learner centeredness (SMASE, 2013).

Kenya has eight broad aims of education where long term objectives of primary education are derived from. Geometry has its long–term objectives known as the course objectives (Twoli, 2011). Kenyan teachers are assumed to be perfect after training similar to United States. According to Primary Teacher Education syllabus (2004), application of mathematics to real life experiences and practical approach to teaching and learning is emphasized. The syllabus therefore addresses the general objectives of the course as well as specific objectives for each topic and in this case geometry. The teacher should be able to communicate to pupils using mathematical language, identify appropriate teaching approaches for relevant geometry content, and vary teaching approaches according to the
opportunities that may arise during the geometry lesson and also identify and use appropriate and locally available teaching / learning resources.

CEMASTE A has tried to help train mathematics teachers to shift classroom practice from content- based to activity – focused teaching and learning, teacher- centered to student centered learning, through use of ASEI (Activity, Student Centered, Experiment and Improvisation) and PDSI ( Plan. Do. See and Improve Approach) (TPC, 2011). However, majority of the observed lessons by SMASE monitoring and evaluation team in the year 2013, were dominated by the teachers, and in some cases activities were not well planned as learners were put in groups but worked individually (SMASE, 2013). This study therefore sought to determine methods used by mathematics teachers in Thogoto zone. The study further sought to establish influence of practical approach in teaching geometry on learner’s performance in this zone.

2.3 Models of Teaching Geometry Concepts

In any communication process there are two main points, the source and the receiver. The source sends out information or message and the receiver plays the role of the message recipient. In between the source and the receiver there can be other varying modes of transmitting the message (Twoli, 2007). This creates a system of instruction where knowledge, skills and attitudes are acquired. According to Ayot and Patel (1987) Glassers’ model of teaching and learning follows a systems approach in that:

- A goal is in form of instructional objectives
- There are four elements represented by boxes
- Harmony is reflected by the reversible arrows among elements and
- Feedback is provided to all elements through performance assessments.
Figure 2.1 Glassers’ (1962) model of systematic approach

To teach a specific part of mathematics such as geometry concepts following this model, one had to check with learners’ present knowledge and their performance after teaching. The study sought to establish how geometry teaching process is done in Thogoto zone and how this influence student performance in geometry.

2.4 Theories Guiding the Study

According to Mugenda and Mugenda, (2003) a theory is a set of concepts or constructs and interrelations that are assumed to exist among those concepts. The study compared constructivism and behaviorism theories and related them to geometry teaching.

2.4.1 Constructivism theory and geometry concepts teaching

This theory was based on the work of Jean Piaget (1980) and social-historical work of Lev Vygostsky, (1978), Jerome Bruner, (1996) and Howard Gardener, (2007). The theory supports that people build (construct) new knowledge upon their previous knowledge. Hence it can help guide curriculum, instruction, and assessment across all disciplines in our formal education system. Mathematics is seen as a cumulative science in which new results are built upon and depend on earlier results. Geometry concepts build in one level assist logically in building more new geometry concepts in upper levels. Gardner, (2007) described constructivism by indicating that mathematics is a cumulative, vertically
structured discipline. One learns geometry by building on the geometrical concepts previously learned.

Constructivist approach on mathematics education explains that people are born with an innate ability to learn and use mathematics. Human beings vary considerably in their innate mathematical abilities, environments and have varying levels of mathematical knowledge, skills, and interest. There are huge differences in mathematical knowledge and skill levels among students at any particular level. Mathematics curriculum, instructions and assessments need to appropriately consider these differences through use of appropriate constructivist teaching and learning principles (Richard, 2002). The study compares standard six and seven geometry content. Geometry concepts are developed in stages based on earlier taught content to new and complex content at higher levels. This study sought to establish effects of practical teaching on performance in geometry using standard seven syllabuses content.

2.4.2 Behaviorism learning theory and geometry learning

Educators using this behaviorist framework, preplan a curriculum by breaking a content area into a hierarchy of sequenced parts ranging from simple to complex. Assumptions are made that observations, listening to explanations from teachers who communicate clearly, engaging in experiences activities and practising sessions with feedback can result in learning. This can produce a whole or more encompassing concept (Gagne, 1965; Bloom, 1956). Furthermore, learners are viewed as passive in need of external motivation and affected by reinforcement (Skinner, 1953) thus educators spend their time developing a sequenced, well structured curriculum and determined how they can assess, motivate, reinforce, and evaluate the learner. Progress by learners is assessed by
measuring observable behaviours outcome on predetermined tasks (Fosnot, 1989). Geometry teaching is expected to achieve various specific objectives according to KICD mathematics syllabus content for standard seven. This can lead to a behaviour change in geometry problem solving among the learners. This study sought to establish effects of practical teaching on student’s performance and their attitudes towards geometry.

2.5 Teaching and learning strategies and geometry teaching

Mathematics has often been viewed as an abstract and dry subject and especially in geometry teaching. According to Kandugan (2007), learning mathematics is more than just by rote and for passing examination. There is need for the students to be active participants in the learning process for which responsibility for and ownership of learning is emphasized. In many African countries, the teaching methods used are poor since they lack in many areas student-centeredness, student activities, experiments and improvisation. “Chalk and talk “, method is practised in many of the African countries. Most of the African countries report that the teaching is examination oriented and rote learning is more than practised (Munyao, 2013). Students should be made to see mathematics as necessary for living in real world.

According to Twoli, (2007), a teaching learning strategy refers to the way in which content is organized and presented in an instructional process. It involves weighing out the available options in the manner in which the content is presented to the learners. The strategy used should facilitate the teacher in achieving the set instructional objectives in geometry teaching. The following factors should be considered by the teacher when choosing the strategy to be used: nature of the content or topic being taught in this case
geometry, availability of teaching and learning resources, time available to cover the content, entry behavior of the learners and size of the class.

There are two main teaching strategies namely expository and heuristic.

(a) **Expository strategy**: this is also known as transmission strategy. It largely directs instructions from the teacher telling the learner. Learners passively listen and take notes. The teacher becomes the centre of nearly all the activities in the classroom. This enhances transfer of basic information for learners to memorize and reproduce, leading to shallow learning.

(b) **Heuristic strategy**: this is also known as discovery or facilitation. It is indirect with the teacher only helping the learner to find out by posing questions, guiding, indicating sources of information and sharing ideas, problems and solutions. This is learner centered as the learner is at the centre of most learning activities. Teachers’ role is minimal but vital as he/she takes the role of a facilitator and guiding learners, providing suitable resources to ensure that the learner achieves the set objectives. This is considered as a deep learning strategy.

Expository and heuristic strategies are based on the proportion of the involvement of both the teacher and the learner in the geometry learning process. The two approaches or strategies are labelled inductive and deductive. This is based on the processor order of the steps followed in learning new materials or content. In geometry both approaches can be used. Inductively sum of angles forming at a point on a straight line adding to $180^\circ$ can be generalized for all similar situations through use of examples leading to a conclusion and hence determine the law. Deductively the rule, “the sum of angles at a point on a
straight line is equal to 180°, is then followed up by various examples to verify the rule (Twoli, 2001). The selection of appropriate teaching strategies depended on whatever teaching approach was the most effective and more efficient in enhancing the learning of geometry concepts. All this determined appropriate teaching methods and effective use of KICD primary mathematics syllabus and development of geometry concepts in pupils, hence determine performance in geometry. Practical work motivated pupils, by stimulating interest and enjoyment. This study sought to establish influence of practical approach as a heuristic strategy on performance in geometry.

2.6 Organizing for effective teaching in geometry content in primary schools

Waihenya, (2001) noted that poor and inappropriate teaching methodology is one of the factors attributed to students failure in mathematics. The mathematics primary syllabus is a document which shows the mathematics content to be covered in a given time at particular level. The document gives guidance to teaching/learning process (KIE, 2002). The process of communication is vital if learning of geometry is to take place in a classroom. In communication process there are two main points, the source and the receiver. In this case the receiver is the pupils and the source is the teacher (Twoli, 2007). Instructional objectives are the objectives to be achieved within a geometry content teaching session. These instructional objectives help the teacher in organizing content, identifying teaching materials and planning teaching activities relating them to syllabus objectives and content in each level (MoE, TPC, 2011).

Effective geometry teaching requires understanding of what pupils know and need to learn, a challenging and supportive learning environment and continually seeking improvement. Geometry assessment should enhance students' learning and also act as a
valuable tool for making instructional decisions by furnishing useful information to both teachers and pupils (NTCM, 2000). Teachers are expected to prepare schemes of work, lesson plans and lesson notes and organize teaching learning activities and resources for effective geometry teaching. SMASE, 2013 lessons observation, headtechers reported that mathematics teachers always made schemes of work but frequently prepared lesson plans. However, majority of the observed lessons were dominated by the teachers, and in some cases activities were not well planned (SMASE, 2013). This study sought to establish influence of practical learner-centered approach on geometry teaching and learning using standard seven syllabus geometry content.

2.6.1 Teaching learning materials in primary level geometry teaching
The term instructional materials, teaching resources, teaching aids and audio – visual aids mean more or less the same thing. These are aids that teachers use to assist learning and also increase interest in learning. Teachers use resources to enhance student participation in class for effective learning and teaching. Teachers agreed that their schools had adequate resources and that there were many resources around the school environment during lessons observation (SMASE, 2013).

In geometry, various teaching/learning resources recommended for use include: (i) standard one to three - shapes including circular, rectangular, triangular and straight edges and (ii) standard four to eight- rulers, pair of compasses, set squares, protractors, tape measures, strings and ropes.

The teacher is also given the leeway to improvise other appropriate resources for effective teaching (KIE, 2006). When resources are not readily available; teachers are advised to improvise and make good use of those material that are affordable and
available in their environment. SMASE report indicated that most teachers introduced their geometry lessons using sketches and geometrical constructions on chalkboard (SMASE, 2013). This study sought to establish how mathematics teachers improvise geometry related teaching and learning resources while teaching standard seven in primary schools in Thogoto zone.

2.7 Teaching and learning mathematics and geometry concepts

Investigations in Spain had indicated that Prospective Primary Teachers (PPTs) studying in the education faculty had basic errors concerning mathematical content and in particular about geometrical concepts. It was found that these teachers had problems in performing activities related to the concept of construction of perpendicular line from a point to a line, which is a basic geometry idea in primary school curricula (NTCM, 2000).

Teaching and learning is done systematically using the syllabus which specifies the objectives of content to be taught and which must be related to the goals of education (KIE, 2002). On the other hand, learner involvement, evaluation and conclusion were weaker aspects in the lessons taught by teachers; in some cases activities were not well planned. Most teachers lack organized knowledge of the geometry concepts (SMASE, 2013).

The geometry teaching process is both difficult and challenging. Many teachers teach geometry without knowing enough about the topic. The performance in mathematics in the primary teachers college is poor and the failure rate in the subject is higher as reflected in the primary teacher examination (PTE) results over several years (Waweru, 1994). Most teachers lack organized knowledge of the geometry concepts. This has been
the reason why mathematics has been made an elective subject in the second year of training as from 2006 according to new KIE syllabus for PTE students.

The teacher training colleges have the mandate to train primary teacher (MOE, TPC, 2011) through content, methodology and practical teaching in public schools. The SMASE lessons observation considered classes six, seven and eight. The study sought to established how teaching and learning was done using KIE mathematics syllabus in standard seven classes in Thogoto zone.

2.8 Concept of geometry and spatial development

The word geometry is derived from the Greek word “Geo” for earth and “Metria” for measurement. Geometry is a branch of mathematics that deals with shapes and sizes, relative positions of figures and properties of space. The building blocks of modern geometry include points, lines, and planes (Mugo, P. & Kisui, R. 2010). Today geometry is still taught everywhere in schools, although its form and content have been modernized to meet changing needs and new ideas. Plane geometry is concerned with plane figures. This deals with familiar figures like circles, triangles, squares, and angles. These have only two dimension, length and width. Solid geometry has three dimension length, width and height. Plane and solid form the geometry taught in primary schools. Geometry has an important place in school mathematics curricula. It develops students’ spatial ability and logical reasoning skills (French, 2004).

Pupils learn geometry notions and properties by exploring their environment, thus it is very important that primary school teachers have a good base in elementary geometry. Most geometry lessons had very limited use of project method, role play, outdoor activity, discovery or practical approach. Geometry teaching was noted to likely
introduce some misconceptions to the pupils on sketching and geometrical constructions (SMASE, 2013). This study therefore sought to establish pupil’s misconceptions and errors in plane and space geometry in standard seven in Thogoto zone.

2.8.1 Standard seven geometry concepts

Standard seven geometry topics include both lines and angles (KIE, 2012). The content differs with standard six but topics are related. On lessons observations by SMASE, on the mathematics content, it was noted that some geometry lessons covered functions which was not part of the intended learning objectives. The introduction was noted to likely introduce some misconceptions to the pupils. Teachers mixed teaching content while introducing their lessons.

Table 2.2 gives a comparison between standard six and standard seven geometry concepts.

Table 2.2: Kenyan standard 6 and standard 7 geometry content

<table>
<thead>
<tr>
<th>STD 6: LINES</th>
<th>STD 7: LINES &amp; ANGLES</th>
</tr>
</thead>
</table>

Draw bisecting lines using a rule and a protractor

Perpendicular lines

Parallel lines from a point to a line

**ANGLES**

Vertically opposite angles

Supplementary angles

Constructing of $90^\circ$, and $60^\circ$

Bisecting angles

Drawing triangles

Interior and exterior angles of a triangle

Parallel lines and transversals

Perpendicular bisector of lines

Problems involving angle properties of parallel lines

Angle properties of quadrilaterals

Construction of triangles and circles

Pythagorean relationship $3:4:5$

Nets of cubes, cuboids and cylinders

Models of cubes, cuboids and cylinders

Making patterns

---

**Source:** KIE, 2012, Mathematics syllabus, KICD

The table indicates geometry content in standard six and seven. These determined concepts to be developed during teaching and learning in standard seven classes. Standard six content and concepts showed what pupils had already learned, giving base of teaching from known to unknown. This study sought to establish effects of practical teaching on student’s performance in standard seven geometry content.

**2.8.2 Teaching and learning of geometry concepts**

During lessons observation by SMASE observers, out of the ten lessons observed in Geometry, most were on construction of angles and triangles, while one was on properties of circles. Moreover, lessons largely involved lecture method characterized by teacher questions, some problem solving, demonstrations or class discussions. These
lessons had very limited use of project method, role play, outdoor activity, discovery or practical approach. Majority of the observed lessons were dominated by the teachers, and in some cases activities were not well planned (SMASE, 2013).

The study compared practical approach with teacher’s common practised methods as indicated by SMASE and therefore, this study aimed at establishing various methods used by mathematics teachers in teaching geometry concepts in standard seven in Thogoto zone

2.8.3 Conceptual theory of Vergnard

The official curriculum knowledge can be structured in concepts. In France, the theory of Vergnard (1990) is used where he considers a concept as a group of three sets namely, situation - which give sense to the concept, operative invariants – including concept- in – act and theorem – in – act, and linguistic and non linguistic forms for representing the concept, its properties, situations and treatment procedures (Rolet, 1996).

Rolet, (1996) explains that primary school curriculum distinguishes four classes for the concepts explicitly or implicitly present namely; basic objects like points, segments, lines and angles. These are not explicitly defined but only used in different problems, constructed objects like midpoint, circle, special quadrilaterals or triangles, basic relations like length equality, perpendicularity and constructed relations like parallelism and symmetry. Content may be developed for learners to understand it conceptually through practical activities. Wellington, (2000) referred to them as concept words that denote concepts of various types. The level of abstraction increases as words used have both mathematical and everyday meaning which bring about confusion and difficulties to the learners. Clerk and Peterson, (1986) argued that the way teachers interpret and
implement curricula is influenced significantly by their knowledge and beliefs. The approaches are determined by teacher’s conceptions. On a continuum between teacher-centered and learner centered lessons, most were largely teacher-centered. In terms of classes taught, teachers who taught class 6 and 7 had a mean perception of 3.55, those who taught class 7 and 8 had a mean rating of 3.43, while those who taught class 6 and 8 had mean of 3.38 using a rating scale of 4 (SMASE, 2013).

Mathematics results in Thogoto zone have always been below average and especially in public primary schools. Moreover, during geometry teaching and learning resources like textbooks and geometrical sets were not adequate in some observed lessons, which hampered learners’ progress in attempt to give tasks and assignments SMASE, 2013).

This study sought to determine whether mathematics teachers use available resources effectively in teaching geometry in public primary schools in Thogoto zone.

2.9 Assessment and Performance in Geometry

Every year, thousands of Kenyan pupils sit for the Kenya certificate of primary education (KCPE) examination. This examination is done at the end of the eighth year of primary education. Over the years, discrepancies have been observed in the performance of pupils in KCPE geometry questions in each year of KCPE examination. Although pupils may be of comparative abilities, learn in the same class and follow same syllabus, their academic performance still vary. In the year 2011, Q26 was a geometry question discussed in KCPE newsletter among the most failed. The question tested on skill of construction, knowledge of angles and properties of triangles. Pupils who chose the correct answer represented 39.49% (KNEC, 2011 KCPE report). Similarly teachers in TTCs sit for their PTE at the end of their 2nd year. In the year 2013, mathematics PTE
Paper 1, Q13 and mathematics PTE paper 2, Q2, tested the skill of constructing a perpendicular from a point to a line and knowledge of how to teach geometry content respectively (KNEC, PTE Paper 1 and Paper 2, 2013). There is general similarity in KCPE and PTE assessments in geometry content. If teachers are trained effectively then their teaching methods should be effective. SMASE process of tracking of teachers had some incidental impacts for instance resources were reportedly available but not well-utilized during the lessons; there were limited cases of classes with mathematics corners or charts on walls; and claims of using improvised materials were not backed by actual classroom practices. Standard seven classes is the final class before standard eight, which is assessed externally using KCPE. This class was also used during SMASE lessons observation in 2013. This study therefore intended to establish teaching methods used by mathematics teachers and compare them with pure practical teaching approach on effects in student’s performance in geometry using standard seven syllabus geometry content.

2.9.1 Learners misconceptions in Geometry

The concept of a straight line which has no width means that a line cannot be seen. A pencil mark is made on paper to represent a straight line. This is not a straight line but a mark to show the position and direction of the line. A point has a position but no size, without size it could of course not be seen, hence a pencil dot however small is really a point, but a mark on the paper to represent the position of a point. The shortest distance between two points is a straight line. Lines intersect to form triangles, angles, quadrilaterals and other polygons (Mugo and Kisui, 2010).
Use of geometrical terms such as face, edge and vertex also lead to misunderstanding and misconceptions. Learner’s prior experiences with geometrical concept embody the concept image. For some students this concept image may not develop; for others, it may not be coherently related to formal concept definition. These misconceptions have to be addressed during instruction. Some of the common misconceptions include: recognition of geometric shapes, solids, drawings of their nets and constructions (SMASE, 2011). This study sought to identify common errors and related misconceptions made by learners during two weeks geometry teaching, using Pre and Post assessments question analysis.

2.9.2 Students performance in KCPE mathematics geometry questions

Table 3.3 indicates percentage passes in various geometry questions in the year 2009 and 2011 KCPE examination. The table shows that most geometry questions had less than 50% pass. This clearly indicates that pupils had problem with geometrical concepts.

<table>
<thead>
<tr>
<th>Year</th>
<th>Question no</th>
<th>% Pass</th>
<th>Year</th>
<th>Question no</th>
<th>% Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>5</td>
<td>37%</td>
<td>2011</td>
<td>10</td>
<td>42%</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>33%</td>
<td></td>
<td>20</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>41%</td>
<td></td>
<td>21</td>
<td>50%</td>
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<tr>
<td></td>
<td>16</td>
<td>51%</td>
<td></td>
<td>23</td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>29%</td>
<td></td>
<td>26</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>32%</td>
<td></td>
<td>36</td>
<td>30%</td>
</tr>
</tbody>
</table>
In 2009, 720455 pupils sat for KCPE mathematics examination, attaining a national mean of 24.78 and standard deviation of 10.09. Out of four most failed questions with less than 30% pass, geometry had one question, Q41 that tested basic properties of a rectangle and Pythagorean Theorem KNEC, (2009). In 2011, 768610 pupils sat for KCPE mathematics examination, attaining a national mean of 26.16 and standard deviation of 10.01. One question was discussed having been the most failed, Q26 that tested basic idea on constructing a perpendicular line from a point to a line KNEC, (2011). This study sought to establish effects of practical teaching on student’s performance in geometry. The study further sought to identify common misconceptions in geometry.

2.9.3 Summary of the literature review

Reviewed literature revolves around teaching methods: practical learner -centered and teacher- centered approach, use of teaching learning resources, models of teaching, errors, misconceptions and attitudes in geometry teaching. It focuses on influence of practical approach on student performance after the process of teaching.

The traditional view of teaching has been teacher – centered. On this approach the teacher transmits facts while learners are passive recipients. This study sought to establish how teachers teach, use teaching/ learning resources and plan teaching/ learning activities in geometry in this zone.

Practical activities enhance the pupils’ understanding in addition to sharpening their creative skills. An effective teacher plans practical work with specific learning objectives
in mind. This study therefore sought to determine extent to which primary mathematics teachers used practical teaching approach and also established influence of this method in teaching geometry on learner’s performance.

Mathematics teaching is the process by which teachers transmits their experiences to learners. Learners participate in the conceptual development process by acquiring knowledge, skills and attitudes. This study therefore sought to determine methods used by mathematics teachers.

This study sought to establish how mathematics teachers improvise geometry related teaching and learning resources while teaching standard seven in primary schools. The study sought to determine whether mathematics teachers use available resources in teaching geometry concepts in public primary schools in Thogoto zone.

This study focuses on standard seven geometry syllabuses content. It sought to establish attitudes towards geometry teaching and learning among teachers and pupils. It further sought to establish influence of practical learner-centered approach on geometry teaching and learning using standard seven syllabus geometry content.

In any communication process there are two main points, the source and the receiver. The source sends out information or message and the receiver plays the role of the message recipient. The study sought to establish how geometry teaching process is done in Thogoto zone and how this influence student performance in geometry.

The study sought to established how teaching and learning is done using KIE mathematics syllabus. It sought to establish pupil’s misconceptions and errors in plane and space geometry in standard seven. This study sought to identify common errors and
related misconceptions made by learners. The researcher used geometry question analysis on question given during pre and post assessments. Mathematics results in Thogoto zone have always been below average and especially in public primary schools. This study sought to determine whether mathematics teachers use available resources effectively in teaching geometry.

Geometry concepts build in one level assist logically in building more new geometry concepts in upper levels. One learns geometry by building on the geometrical concepts previously learned. The study compares standard six and seven geometry content. This study sought to establish effects of practical teaching on performance in geometry using standard seven syllabuses content. This study further sought to establish effects of practical teaching on student’s performance and their attitudes and behaviours towards geometry.

These instructional objectives help the teacher in organizing content, identifying teaching materials and planning teaching activities, relating them to syllabus objectives and content in each level. This study sought to establish influence of practical learner-centered approach on geometry teaching and learning using standard seven syllabus geometry content.

Geometry teaching was noted to likely introduce some misconceptions to the pupils on sketching and geometrical constructions. Standard seven geometry topics included both lines and angles spirally developed from lower level content. This study therefore sought to establish pupil’s misconceptions and errors in plane and space geometry in standard seven in Thogoto zone.
CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

Chapter three covers research methodology which is organized under the following subheadings: research design, location of study, target population, sample size and sampling techniques, research instruments, pilot study, data collection, data analysis and ethical considerations.

3.1 Research design

This study was based on Quasi-experimental design. This was both quantitative and qualitative research. The researcher attempted to understand cause and effect of use of casual comparative research. In this case this study was aimed at determining whether or
not practical teaching of geometry has causal effects on student geometry performance. Random sampling was used to divide pupils into two homogenous groups in terms of class size. Cards x and y were used. Both group, experimental group (x) and control group (y) experienced the same conditions, with exception of the experimental group, who received the influence of the independent variable, the practical teaching. A pre test geometry quiz (appendix VI pg113) was administered. All scripts were collected and marked. Experimental group (x) received instructions through practical approach while control group (y) received instruction through common teaching methods as earlier indicated by SMASE during lesson observations. Geometry teaching was done by mathematics teachers from sampled schools. The researcher selected various mathematics teachers using respective sampled schools teaching time table.

The researcher conducted an inset on syllabus interpretation, teaching activities (appendix v pg111) and assessments methods to teachers teaching the experimental group. A post test was given to both groups before teaching started. Teaching took two weeks, considering ten lessons of thirty five minutes for each group. A post test was then given again to both groups using an exam time table where mathematics teachers were used as invigilators. Marking was done using prepared marking schemes and analysis of marks done. Analysis was done using frequency tables, mean, standard deviation, t-test and analysis of variance. After two weeks of teaching and learning, mathematics teachers and pupils filled questionnaires (appendix VII pg116 and VIII pg119 respectively). The questionnaire had closed ended questions for the teachers and pupils. Teacher’s questionnaire evaluated attitudes of teachers towards methods used, use of teaching/learning resources and various other teaching practices. Pupil’s questionnaire established
their attitudes towards geometry teaching, methods used by teachers while teaching and teaching materials used. This data was later analyzed using SPSS computer package.

![Research Study Design](image)

**Figure 3.1 research study design**

### 3.1.1 Variables

According to Mugenda and Mugenda, (2003) a variable is a measurable characteristic that assumes different values among the subjects. Experimental design and casual comparative research concerns relationships between variables. The independent variable which was the cause and the other was the effect hence dependent variable. In this study independent variable was practical approach in teaching / learning geometry. The experimental group (x) received practical geometry teaching while the control group (y) received common geometry teaching method. Both groups were given pre-test and post-test assessments. The dependent variable was performance in geometry. Intervening variables are other variables that may affect the result but not considered. These included time allocation, pupil’s attendance, mathematics curriculum and other teaching methods.
3.1.2 Location of the study
This study was based on public primary schools in Thogoto educational zone in Kiambu County. Lessons observation study conducted by SMASE in 2013 was done in forty (40) public primary schools offering the National Curriculum of 8-4-4 education cycle in 13 Counties. Kiambu was one of the thirteen and hence the reason why the researcher considered Thogoto zone in the said county. The study intended to find out how practical teaching of geometry influence student performance in geometry.

3.2 Target population
Target population refers to all members of a real or hypothetical set of people or events to which a researcher wishes to generalize the results of study (Borg & Gall, 1989). The researcher targeted standard seven classes in 12 public primary schools, in four administrative clusters in Thogoto zone. The clusters were Kikuyu (Kikuyu, Musa Gitau and Kidfarmaco), Thogoto (Thogoto, Thirime and Magutuini), Kinoo (Gitiba, Ngure and Mama Ngina) and Kabete (Uthiru, H.G.M and Rungiri). One school from each cluster was randomly sampled to form a group of four schools. The zone had a total of 12 schools, 24 mathematics teachers and 1035 pupils (518 boys and 517 girls). The four sampled schools had a total of 8 mathematics teachers and 343 pupils. All schools were public with two boarding schools. All schools used similar KICD mathematics syllabus.

3.3 Sampling Techniques and sample size
Mugenda and Mugenda (2003), define sampling as the process of selecting a number of individuals for study in such a way that the selected small group to represent the larger group. A sample is therefore a smaller group obtained from the accessible population. Technique adapted was random sampling. Thogoto zone was divided into four clusters with three schools in each. Cluster sample was obtained by simply sampling one school
from each cluster. Four schools were randomly sampled. Teachers and pupils from each sampled school were further randomly sampled. This sampling technique allowed cases that had the required information with respect to the objectives of the study. (Mugenda & Mugenda, 2003). This sampling was appropriate for quantitative studies and allowed for use of inferential statistics in data analysis. According to Mugenda and Mugenda (2003), a researcher should take as big sample as possible because it reduces the sampling error.

Table 3.1: Sampling grid for schools, teachers and pupils

<table>
<thead>
<tr>
<th>Group</th>
<th>Target</th>
<th>Sample</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools</td>
<td>12</td>
<td>4</td>
<td>33.33</td>
</tr>
<tr>
<td>Pupils</td>
<td>1035</td>
<td>343</td>
<td>33.14</td>
</tr>
<tr>
<td>Teachers</td>
<td>24</td>
<td>8</td>
<td>33.3</td>
</tr>
</tbody>
</table>

3.3.1 Cluster sampling

Cluster sampling is a successive random sampling of units, or sets and subsets. In this study Thogoto zone was divided into four clusters, namely: Kikuyu, Thogoto, Kinoo and Kabete. Each cluster had three schools. One school was random sampled from each group to form a sample of four schools. This sampling helped to reach schools that avoid teaching geometry and giving the same to Thogoto college student during teaching practice. This was 33% of the total schools in Thogoto zone. The schools were evenly spread in the zone and had similar environmental characteristics. Mathematics teachers from four sampled schools were twenty four.
3.3.2 Random sampling

Random sampling is a form of probability sampling in which each member of the group has an equal chance of being selected. This was used in obtaining experimental group (x) and control group (y). There was a total of 343(33%) from the four sampled schools. Each school had two standard seven classes. Pupils were stratified sampled using gender and prepared cards marked X and Y from each class. A total number of boys and girls were considered. Each class received cards x and y in equal number, equal to the total number of boys or girls in that class. Each pupil picked a card marked either X or Y. Two homogenous groups X and Y were formed with similar number of boys and girls. The researcher considered group x as the experimental and group y as control group.

The mathematics teacher teaching in various standard seven classes in their respective sampled schools were eight. Teachers were randomly sampled using X and Y cards. Each school received two, x and y cards for teachers sampling. Two teachers picked the cards either x or y. There were a total of four x teachers and four y teachers from the four sampled schools. The four x teachers (Sx) taught group X pupils using practical activities (appendix Vpg110) as directed by researcher after mathematics inset on the given practical activities. The other four y sampled mathematics teachers (Ry) taught group Y pupils using common teaching methods depending on their choice. Teachers Sx received in-service on practical activities while Ry teachers received the content. Teaching took two weeks.

Experimental group X, received teaching instructions from in serviced standard seven mathematics teachers on syllabus, content and practical teaching approach. Practical teaching involved use of project method, role play, outdoor activity, discovery or
practical hands on activities (SMASE, 2013). The control group Y, received geometry teaching from their mathematics teachers using common practised method. This method involved lecture method characterized by teacher questions, some problem solving, demonstrations or class discussions (SMASE, 2013).

3.3.3 Class room layout, observation and interviews
Each class was made of boys and girls sampled as x or y pupils. Each school had two standard seven class, x and y. Teacher Sx taught x class and Ry taught y class. The researcher frequently observed lessons in various schools within the two week of teaching. Each teacher was observed twice (appendix XII pg 124). Mathematics teachers were also involved in oral discussions, on methods and teaching learning resources. Head teachers of respective sampled schools were engaged in monitoring and evaluation, ensuring correct content was taught.

Table 3.2: Sampling grid for boys, girls and teachers in each sampled school

<table>
<thead>
<tr>
<th>Sampled Schools</th>
<th>Std 7 Boys</th>
<th>Std 7 Girls</th>
<th>No of Classes</th>
<th>Standard seven</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANGI</td>
<td>36(50%)</td>
<td>36(50%)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>HGM</td>
<td>20(50%)</td>
<td>20(50%)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>NGR</td>
<td>18(50%)</td>
<td>19(50%)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>MAGT</td>
<td>11(50%)</td>
<td>11(50%)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Teachers</td>
<td>Sx</td>
<td>Ry</td>
<td>Sx</td>
<td>Ry</td>
</tr>
</tbody>
</table>

Sx- teaching using practical approach as guided by researcher
Ry- teaching using common teaching methods of their choice.

3.4 Research Instruments
Research instruments were developed to help in collection of necessary information. The data for this research was collected using a structured questionnaire and standard assessment test. The questionnaire had closed ended questions for the mathematics teachers and pupils while standard test was used to collect information from pupils. The main advantage of close ended questions is that they are easier to analyse since they are in an immediate usable form. They are also easy to administer because each item is followed by an alternative answer and therefore is economical and time saving (Mugenda and Mugenda, 2003).

3.4.1 Pupils’ geometry standard test
This was an achievement test meant to measure acquisition of knowledge or skills. This provided the researcher with useful data or information on misconceptions and errors in geometry before and after teaching. The data obtained were quantitative analyzed. There were two geometry standard tests (appendix VI pg113) for standard seven pupils. Pre test was given at the start of two weeks while Post test was given after the two weeks teaching. Each test consisted of ten geometry questions. Questions were generated from standard seven syllabus considering specific objectives and content of geometry. The test had five multiple choice items and five completion items questions. A table of specification was used while setting the test. Questions tested the necessary area of cognition, set from all parts of standard seven syllabus and considered specific objectives of each sub topic. Pupils worked and filled their answers in the blank spaces from question one to five while circling the correct option for question six to ten.
3.4.2 Teachers’ questionnaire
This was administered to individual teachers to seek their opinions on specific aspects of geometry teaching. Teachers’ questionnaire (appendix VII pg116) was divided into section A, B and C. Section A, contained simple specific questions aimed at gathering teachers’ demographic information. Section B, contained several question items aimed at establishing teachers’ attitudes towards geometry. Teachers gave their opinions using item printed likert scale rated 0-Strongly Disagree, 1- Disagree, 2- Not sure, 3-Agree and 4- Strongly agree. Section C, had both open and close ended questions. These consisted of general open ended questions that helped gather data on preparation, teaching methods, teaching and learning resources and misconceptions and errors.

3.4.3 Pupils’ questionnaire
This was administered to individual pupils to seek their opinions on specific aspects of geometry teaching. Pupils’ questionnaire (appendix VIII pg119) had six questions. The questions were aimed at collecting information on teaching methods, attitudes and opinions towards geometry in their respective classes. Pupils ticked or filled blank spaces with their appropriate answers.

3.5 Pilot study
The pilot study was conducted to ascertain the accuracy of the research tools. The researcher sampled one school out of twelve schools in Thogoto zone. The school was not among the four purposively sampled schools for the main research. Randomly sampled standard seven pupils from each standard seven class were given the geometry questions to attempt and a questionnaire to answer. Two standards seven mathematics teachers were also given geometry questions and a questionnaire to answer. Mathematics
teachers were requested to indicate any difficult or ambiguous items in the geometry questions and questionnaires. The errors were rectified before the actual research for validity and reliability (Orodho, 2005)

3.5.1 Validity

Validity is the accuracy and meaningfulness of inferences, which are based on research results (Mugenda & Mugenda, 2003). It is the degree to which results obtained from the analysis of the data actually represents the phenomenon. Instruments were designed to include all the elements under study. A pilot study was conducted in one of the twelve schools in Thogoto zone. The validity of research instruments was established by the use of expert opinions and literature searches to examine what other related studies had used. Discrepancies were addressed by the relevant adjustment, corrections and rephrasing of statements and questions where necessary. According to Borg and Gall (1989) validity is established by expert judgment. Therefore the researcher sought the assistance of the supervisor, with view to improve the content, validity and reliability of the instruments.

3.5.2 Reliability

According to Mugenda & Mugenda, (2003) reliability is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. Therefore a pilot study was carried in one public school where geometry questions were answered and questionnaire filled by standard seven pupils in their respective mathematics classes. Reliability is influenced by random error. As random error increases, reliability decreases. Random error is the deviation from a true measurement due to factors that have not effectively been addressed by the researcher (Mugenda & Mugenda, 2003). The researcher pre-tested the questionnaires to establish whether there
were ambiguous questions and corrected them to increase the reliability of the data collected. A sample of 30 respondents was arbitrarily selected to participate in test and questionnaire ratification. Their results were determined using a prepared marking scheme. The split-half technique was used to assess reliability by correlating scores \( x \) for pupils \( x \) and scores \( y \) for pupils \( y \) in the two classes. Pearson’s product moment correlation coefficient formula to determine the correlation coefficient \( r \) between the two set scores was used to determine reliability. A value of 0.5 and above was acceptable and tools assumed reliable as follows:

\[
    r_{xy} = \frac{\sum (x-x) (y-y)}{\sqrt{\sum (x-x)^2 \sum (y-y)^2}}
\]

Where \( x-x \) is the \( x \) scores deviation and \( y-y \) is \( y \) scores deviation. According to Mugenda & Mugenda, (2003) if Pearson’s coefficient is closer to 1, the research tools are regarded as reliable. Using Pearson’s product moment correlation coefficient formula, the scores were computed and a correlation coefficient of 0.7 was obtained indicating that the test was reliable.

The questionnaires were filled by two teachers and thirty pupils. The researcher and teachers discussed the findings and rectified the questions removing any ambiguity.

### 3.6 Data Collection

Permission to carry the research was obtained from the National Council of Science and Technology (appendix IX pg120 and X pg120). An introductory letter (appendix XI pg122) to the head teachers was requested by the researcher from the district education
officer (DEO) of Kikuyu district to discuss the research visit to the schools before the study commences.

3.6.1 Logistics and ethical considerations

According to ORI-HSR/ history- ethics, (2010) the consequences of researches on human beings without taking into consideration ethical issues led to formulation of federal rules and regulations and the establishment of international research ethics (IRBs). This study considered various ethical issues hence practical teaching of geometry was done during weekdays to go hand in hand with government education policies. The researcher personally administered the questionnaires to the respondents. Informed consent to participate in the study was obtained from the respondents by explaining the purpose of the study being assured that the information given would be treated as confidential. The respondents were requested not to indicate their names anywhere in the questionnaire for anonymity. Their confidential information was only accessed by the researcher and the supervisor.

3.6.2 Data collection process

The researcher visited the selected schools two times for briefing and administering of research tools. The pretest was given before teaching to all standard seven pupils. The researcher discussed with the mathematics teachers on the topic geometry and requested to be allowed to sample the standard seven pupils using simple cards. This helped divide the classes into two equal groups considering gender in each class. Teaching was done for two weeks by respective mathematics teachers Ry and Sx. The post test was given after three hours of teaching the selected geometry activities. Both pre test and post test geometry tests were designed to discriminate attainment by cognitive levels of achievement. Marking was done using prepared marking schemes, scripts coded, scores recorded and scripts returned to pupils. The teachers and pupils questionnaires and lesson observation were administered by researcher himself. Mathematics teachers and standard
seven pupils were given questionnaire allowing them time to respond anonymously and be more truthful by taking time to think about the questions. The researcher assured them that strict confidentiality was to be observed in dealing with their responses.

3.7 Data analysis techniques
Data analysis techniques are statistical methods which were used to analyze data so that it could be interpreted (Frankford, 1996). Data collected was both quantitative and descriptive in nature. Quantitative data analysis consisted of measuring numerical values from each description such as mean and standard deviation. The result of the analysis was reported in summary form using frequency tables, graphs and pie charts. Descriptive data analysis for close ended questions was done using content analysis. Content analysis describes the form or content or spoken material. Ideas were grouped in themes. Frequency distribution and percentages were obtained using the statistical package for social sciences (SPSS). In coding the factor items were scored from a five likert scale. Descriptive statistics such as mean, percentage and standard deviation were used to analyze demographic data of mathematics teachers and standard seven pupils.
CHAPTER FOUR
PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter presents the findings, interpretations and discussion according to the objectives and research hypotheses.

(a) To determine the extent to which primary mathematics teachers use the practical teaching approach in Thogoto zone.

(b) To establish the resources used in teaching geometry in primary schools in Thogoto zone.

(c) To establish the effects of practical teaching on performance in geometry in primary schools in Thogoto zone.
To determine teachers’ and pupils’ attitudes towards geometry in primary schools in Thogoto zone.

The findings were organized thematically using the study objectives as follows: General and demographic information, extent on use of practical teaching, use of teaching / learning resources, effects of practical approach on student performance and teachers and pupils attitudes towards geometry teaching.

4.1 General and demographic information

The total number of schools sampled was five where one was used as a pilot school. Eighty seven (87) pupils filled pupil’s questionnaire. Fifteen (15) teachers filled the teacher’s questionnaire. Absenteeism affected the return rate.

<table>
<thead>
<tr>
<th>Group</th>
<th>Sampled</th>
<th>R</th>
<th>% R</th>
<th>NR</th>
<th>% NR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pupils</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys (pretest)</td>
<td>180</td>
<td>159</td>
<td>88</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>Girls (posttest)</td>
<td>163</td>
<td>140</td>
<td>85</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Boys (questionnaire)</td>
<td>45</td>
<td>44</td>
<td>98</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Girls (questionnaire)</td>
<td>45</td>
<td>43</td>
<td>96</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Teachers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>8</td>
<td>8</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaire</td>
<td>24</td>
<td>15</td>
<td>63</td>
<td>7</td>
<td>27</td>
</tr>
</tbody>
</table>

Key: R- Returned    NR- Not Returned

Eight teachers did the actual teaching in the sampled four schools. Four teachers used practical teaching approach while teaching treatment group x. The other four teachers
used other commonly used teaching methods. Teachers teaching control group Y had freedom to choose the method while teachers teaching group X used the practical approach as earlier instructed during mathematics inset by the researcher.

A timetable was used for all sampled schools during Pre testing and Post testing. Three hundred and forty three (343) pupils were expected for testing however only two hundred and ninety nine (299) did the tests as the rest (44) were absent. This translated to 87% attendance.

Teacher’s questionnaires were given to eight teaching teachers and seven others mathematics teachers within Thogoto zone. Out of the twenty four (24) teachers in the zone, fifteen (15) filled the questionnaire. This translated to 63%. These high response figures were achieved due to great cooperation between researcher and schools administrators. Absenteeism was a major problem among pupils during geometry teaching.

4.1.1 Teacher’s age and teaching experiences in mathematics

Teacher’s participation in this study by gender was considered. Fifteen teachers participated in this study out of which 53% were males and 47% were females.
Figure 4.1 Teachers participation in this study by gender

Male mathematics participant teachers were slightly more than female teachers. Teachers are role models and having both genders teaching mathematics was an indication that there was motivation to learners to work hard.

4.1.2 Experience of study participants

The researcher considered experience of teaching mathematics teachers. Fifteen teachers (15) out of twenty four (24) answered the question on teaching experience.

Figure 4.2 Mathematics teachers teaching experience

Three fifths (60%) of respondent had an experience of four or less years in teaching mathematics in their current schools while those with experience between five to nine years were 7%. Teachers with experience between ten and thirteen years of teaching mathematics were 13% while 20% had experience of over 13 years. These findings established that geometry topic was being handled by young teachers who were newly posted or employed.
4.2 Extent to which primary mathematics teachers used practical approach in Thogoto zone

The first task was to determine the extent on use of practical methods in teaching geometry, pupils were asked to list down methods used by teachers while teaching geometry. A list of different methods was included in the questionnaire and explanation was done on each method before pupils filled the questionnaire. Eight seven (87) out of ninety pupils (90) filled the questionnaires. Three pupils were absent.

<table>
<thead>
<tr>
<th>Method of teaching</th>
<th>% of teachers who use the method</th>
<th>% of teachers who do not use the method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Outdoor activities</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Demonstration</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Discussion</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Problem solving</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td>Project</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Lecture</td>
<td>7</td>
<td>93</td>
</tr>
</tbody>
</table>

Ninety three per cent (93%) of pupils reported that teachers did not use lecture method and only 7% reported to the contrary. Fifty three percent of the pupils reported that teachers used demonstration method to teach geometry while the rest reported to the contrary. Forty per cent of the respondents indicated that teachers used discussion method.
while the rest reported to the contrary. Eighty seven per cent of respondents reported that teachers used practical activity to teach geometry while thirteen per cent indicated to the contrary.

An effective teacher should plan and use appropriate methods depending with the content. KICD, (2012) observed that different pedagogical approaches can be used to different learning outcomes. Pupils appeared to have confused demonstration with practical teaching despite having been explained on the two methods. Observed lessons, in demonstration teachers used tools and performed activities without involving the learners but practically both teachers and learners were involved in geometrical activities inside and out of class. According to pupils, the findings showed that Thogoto mathematics teachers used various methods of teaching but preferred practical method and demonstration methods. According to Waihenya(2001) poor and inappropriate teaching methodology is one of the factors attributed to learners failure in mathematics. In lecture method learners passively listen and take notes. Demonstration method was used by fifty three per cent according to pupils. This indicated that there was an attempt towards practical teaching by teachers. Forty percent of teachers used discussion methods. In discussion both teachers and pupils were involved in minds on activities but this was purely within the classroom. Learners passively listened and took notes. They only memorized and reproduced, leading to shallow learning. Majority (87%) of respondent indicated practical method was used while 13% responded to the contrary.

The study further established extent teachers use practical approach. This was done through a likert scale with a scale ranging from strongly disagree (SD) to strongly agree.
Teachers gave their preferred methods. Fifteen teachers out of twenty four responded to the questionnaire.

<table>
<thead>
<tr>
<th>Ser. No</th>
<th>Attitudes of teachers on geometry teaching</th>
<th>SD</th>
<th>D</th>
<th>NS</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Geometry concepts are simple to teach in primary school.</td>
<td>7%</td>
<td>26%</td>
<td>7%</td>
<td>53%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 4.4 teacher’s attitude and preferred methods in teaching
Three fifths (60%) agreed that geometry concepts were easy to teach while 33% responded to the contrary. Sixty seven percent (67%) agreed that practical teaching took more time while twenty percent (20%) disagreed. A fifth (20%) agreed that discussion method was easier than practical teaching while seventy three percent (73%) disagreed. Twenty seven per cent (27%) agreed that lecture method was easier than practical teaching while seventy three per cent (73%) disagreed. Finally more than three quarters (79%) agreed that demonstration method was more commonly used to teach geometry while fourteen percent (14%) disagreed.

The findings indicated that teacher’s preferred demonstration method than practical teaching as the latter took more curriculum specific time. Similarly teachers avoided discussion method for practical teaching. These findings supported SMASE, 2011 findings, that teachers tend to use talk and chalk method rather than organizing practical activities in geometric conceptual development. According to Munyao, (2013) most African countries report that teaching is examination oriented and rote learning is more than practiced. According to Twoli, (2007) there are two main teaching strategies namely expository and heuristic. In expository, the teacher is the centre of all activities in the classroom. Learners memorize basic information and reproduce, leading to shallow learning. In heuristic approach the teacher only help the learner to find out by posing
questions, guiding, indicating sources of information and sharing ideas, problems and solutions. This is a learner centered as the learner is the centre of most learning activities.

In geometry both approaches can be used. Problem solving, project work and outdoor activities (practical) was least mentioned.

The findings indicated that most Thogoto teachers preferred expository approaches such as demonstration and discussion. This concurred with pupil’s responses indicating that teachers used variety of teaching methods.

According to French, (2004) practical activities enhance the pupils’ understanding and also sharpen their creative skills. French, (2004) observed that pupils learn geometry notions and properties by exploring their environment. The study established that practical teaching methods were more preferred however teachers used discussion rarely.

*There was a statistically use of practical approach while teaching geometry in Thogoto zone.*

### 4.3 The teaching/ learning resources used in teaching geometry in primary schools in Thogoto zone

The second task was to establish teaching/ learning resources used in teaching geometry. Teachers responded a questionnaire giving their responses in a likert scale. This was analyzed and represented thematically.

**Table 4.5 Use of teaching resources by teachers**
Ninety three point three per cent of teachers indicated that they used teaching resources when teaching geometry as compared to six point seven who reported to the contrary. KIE, (2006) indicated that when resources are not readily available, teachers are advised to improvise and make good use of those material that are affordable and available in their environment. In lesson observation, SMASE report indicated that most improvised materials by teachers in geometry lessons, 20% of the identified materials were on models and solids. Environment was never utilized to the maximum by teachers.

To find out whether teachers used geometrical tools and equipments, pupils named various teaching aids and resources brought in class by the teachers while teaching geometry. Eight seven pupils gave their responses. Three were absent.

<table>
<thead>
<tr>
<th>Category of response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Yes</td>
<td>14</td>
<td>93.3</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.6 Use of geometry tools and equipment when teaching geometry

<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Category response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackboard ruler</td>
<td>No</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>80</td>
<td>92</td>
</tr>
<tr>
<td>Black board protractor</td>
<td>No</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>80</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>----------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Pair of Compasses</td>
<td>No</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>74</td>
<td>85</td>
</tr>
<tr>
<td>Pair of divider</td>
<td>No</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>Set square</td>
<td>No</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>87</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The findings indicated that ninety two percent (92%) of the pupils reported that teachers used blackboard ruler and blackboard protractor. Similarly 85% and 72% of respondents indicated that teachers used compass and pair of divider respectively while only 40% of teachers used the Set Square. Use of blackboard ruler was an indication that teachers drew and used straight lines in geometry. Teachers use of blackboard protractor was an indication that measuring of angles was done despite 8% of teachers not using the blackboard protractor. Eighty five percent of teachers used pair of compasses. The higher percentage of those who didn’t use a pair of divider was an indication that accurate transfer of measurement lacked among the students. This study established that although teachers used variety of geometrical tools in class, use of pair of dividers and set squares was extremely low. Failure to use chalkboard ruler indicated straight lines were rarely constructed on chalkboard. The concept of a straight line is a key concept in geometry. According to KICD, (2006) building blocks of modern geometry include points, lines and planes. A pair of dividers is used in measuring and transferring lengths accurately. Set squares are used in construction of parallel lines and common angles. Paulucii, (1970)
concluded that the teacher should learn how to select the materials and use them effectively for teaching geometry.

A likert scale was further used to establish teaching aids and learning resources used from environment while teaching geometry by teachers. Fifteen teachers responded to the questionnaire by either agreeing or disagreeing.

Table: 4.7 Use of teaching aids and learning resources in teaching geometry

<table>
<thead>
<tr>
<th>SER. NO</th>
<th>Use of teaching and learning resources</th>
<th>SD</th>
<th>D</th>
<th>NS</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teachers use resources from the school environment to teach geometry concepts</td>
<td>27%</td>
<td>13%</td>
<td>13%</td>
<td>34%</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>There are very few geometry teaching and learning resources in the school</td>
<td>20%</td>
<td>33%</td>
<td>-</td>
<td>33%</td>
<td>14%</td>
</tr>
<tr>
<td>3</td>
<td>Teaching geometry is difficulty due to lack of relevant teaching/learning resources</td>
<td>20%</td>
<td>33%</td>
<td>7%</td>
<td>27%</td>
<td>13%</td>
</tr>
<tr>
<td>4</td>
<td>Use of teaching/learning resources in teaching geometry improves understanding of concepts among pupils</td>
<td>13%</td>
<td>20%</td>
<td>-</td>
<td>-</td>
<td>67%</td>
</tr>
</tbody>
</table>

Key: SD- Strongly disagree   D- disagree   NS- Not sure   A- Agree   SA- Strongly Agree

The findings showed that forty seven per cent (47%) of teachers agreed they use resources from the school environment while forty per cent (40%) disagreed. Considering the availability of resources forty seven per cent (47%) agreed that resources were few while fifty three per cent (53%) were to the contrary. Forty percent (40%) agreed geometry teaching was difficult to teach due to lack of relevant teaching resources while fifty three per cent (53%) disagreed. In geometry teaching two thirds (67%) agreed pupils understanding improved when teaching resources were used while thirty three per cent (33%) disagreed? The findings indicated a great percentage of teachers didn’t
understand usefulness of teaching resources in geometry despite agreement that teaching resources improved understanding of geometry concepts.

Teachers further indicated how they used environment in provision of teaching/learning resources. Fifteen teachers responded.

**Table 4.8 Teachers use of resources from school environment to teach geometry**

<table>
<thead>
<tr>
<th>Category of response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Not sure</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Agree</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Two fifths (40%) of the respondents reported that they don’t use the resources compared to forty seven per cent (47%) who reported in affirmative. Thirteen percent (13%) of the respondents were not sure of their response. The study establishes that forty per cent of teachers rarely used teaching resources when teaching geometry.

Teachers further responded to the statement, whether there were fewer geometry teaching and learning resources in the school that related to geometry. Fifteen teachers gave their responses as indicated in figure 4.3 below.
Figure 4.3 There are fewer geometry teaching and learning resources

Forty seven per cent (47%) of teachers agreed that the resources were not enough while fifty three per cent (53%) reported that the resources were adequate. Twenty five per cent (25%) of pupils who never liked geometry had given lack of geometrical tools as a reason. This was an indication that forty seven per cent (47%) of teachers rarely improvised geometry related teaching and learning resources while teaching as earlier shown by KIE, (2006) findings. In geometry the syllabus recommend various teaching/learning resources such as shapes, straight edges, rulers and pair of compasses, set squares, strings and ropes. These were available and could have been be improvised.

The researcher wanted to find out whether teaching geometry was difficult due to lack of relevant teaching / learning resources from teachers. Fifteen teachers gave their responses.

Table 4.9 Teaching geometry was difficult due to lack of relevant teaching / learning resources

<table>
<thead>
<tr>
<th>Category of response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>-------------------</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>Disagree</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Not sure</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>

Fifty three per cent (53%) of the respondents did not find teaching geometry difficult due to lack of relevant teaching learning/learning resources as compared to 40% who found it difficult. This was an indication of lack of practical work. However teachers further indicated that use of teaching/learning resources in teaching geometry improved understanding of geometry among pupils. Figure 4.4 below indicates their responses.

![Figure 4.4 Use of teaching / learning resources in teaching geometry](image.png)
Eighty seven per cent (87%) of the respondents agreed that use of teaching / learning resources in teaching geometry improved understanding of concepts among pupils as compared to 13% who felt differently.

Constructivism theory suggests that knowledge acquisition is better done through learner centered approach, hence need for practical method where learners learn by doing. Teachers used variety of methods ranging from discussion to practical work however practical work and outdoor activities were least used. Teachers failed to use the environment and even failed to improvise teaching/ learning resources available. About 12% of the thirty reasons for difficult content were also attributed to teacher absenteeism, skipping of topics or poor teaching approaches (SMASE, 2013). There was no proper and appropriate use of resources and even geometrical tools in geometrical sets such as a pair of divider and protractor however there was statistically significant use of resources while teaching geometry in Thogoto zone.

4.4 Effects of practical teaching on student performance in geometry in primary schools in Thogoto Zone

The third task was to establish effects of practical teaching on student performance in geometry. The researcher wanted first to find out how effective teachers prepared before teaching. This mainly compared performance between experimental group X and control group Y. A questionnaire was used and fifteen teachers responded. Researcher also embarked on lesson observations and interviews during teaching to establish how the KICD syllabus was being used.

Table 4.10 Teachers preparation of scheme of work
All the teachers had prepared the scheme of work using KICD mathematics syllabus.

Similarly the fifteen teachers indicated on preparation of lesson plans.

**Table 4.11 Preparation of lesson plans**

<table>
<thead>
<tr>
<th>Category of response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Yes</td>
<td>12</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Eighty percent of the teachers had prepared lesson plans however twenty percent did not prepare. Explanation why teachers had not prepared the lesson plans was never given.

NTCM, (2000) indicated that teachers are expected to prepare schemes of work, lesson plans and lesson notes and organize teaching learning activities and resources for effective geometry teaching.

Effect on performance was expressed using errors and misconceptions made by both experimental and control group during pre and post testing. Teachers explained two common misconceptions made by pupils when learning geometry concepts. 60% gave inscribing and circumscribing, 16% gave measuring and constructing angles, 16% gave space figures and 8% gave angles in triangles. Mayberry, (1983) gave common misconceptions as recognition of geometric shapes, solids, drawings of their nets and constructions. Teacher’s explanations were in line with Mayberry’s findings on
misconceptions that included recognition of geometric shapes, solids, drawings of their nets and constructions.

Teachers further rated their pupils on performance as follows: below average 25%, average 20%, above average 40%, and good 10% while excellent had 0%. The rating showed that teachers thought more than 50% of their pupils were above average.

Pre test standard test results on geometry to both control (X) and experimental (Y) group were analysis using SPSS content analysis. The pass rate per question established the reasoning rate.

**Table 4.12 Pass rate in pretest exam in control group(x) and treatment group (y)**

<table>
<thead>
<tr>
<th>Q no.</th>
<th>Concept being tested</th>
<th>N</th>
<th>Pass</th>
<th>N</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Y</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>8</td>
<td>Sum of interior angles</td>
<td>176</td>
<td>59</td>
<td>153</td>
<td>51</td>
</tr>
<tr>
<td>9</td>
<td>Properties of quadrilaterals</td>
<td>135</td>
<td>45</td>
<td>135</td>
<td>45</td>
</tr>
<tr>
<td>10</td>
<td>Construction in geometry</td>
<td>129</td>
<td>43</td>
<td>111</td>
<td>37</td>
</tr>
<tr>
<td>6</td>
<td>Angle properties in triangles</td>
<td>108</td>
<td>36</td>
<td>81</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>Pythagorean relationship</td>
<td>99</td>
<td>33</td>
<td>81</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>Faces edges and vertices</td>
<td>96</td>
<td>32</td>
<td>108</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>Supplement and complement angles</td>
<td>94</td>
<td>31</td>
<td>81</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>angles on parallel lines</td>
<td>94</td>
<td>31</td>
<td>78</td>
<td>26</td>
</tr>
<tr>
<td>1</td>
<td>bisecting and right angled triangle</td>
<td>84</td>
<td>28</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>angle properties</td>
<td>42</td>
<td>14</td>
<td>39</td>
<td>13</td>
</tr>
</tbody>
</table>

Key; N – number of pupils, scoring, Y – control group no, X- treatment group no.

A total of ten questions in geometry were tested to both experimental group and control group. The percentage pass in each concept question was computed. In control group
pretest exam, only one concept (sum of interior angles of a triangle) had a percentage pass above 50%. Properties of quadrilaterals and construction in geometry had less than fifty percent pass rate. The questions with highest reasoning error were angle properties, bisecting and right angled triangle and angles on parallel lines with pass rate of 14%, 28% and 31% respectively. In post test these three concepts had the lowest pass rate. However there was an improvement in pass rate with six questions having a rate above 50%. In the treatment group pretest, questions with highest reasoning errors and thus lowest pass rate were angle properties followed by angles on parallel lines, supplement and complement angles with 26% and 27% respectively. Concepts on sum of interior angles had the highest percentage pass followed by properties of quadrilaterals and construction in geometry at 45% and 37% respectively. In the post test exam in treatment group angle properties had the highest reasoning errors and least pass rate of 41%. All the other concept questions had a pass rate above 50% with sum of interior angles of a triangle leading at 71% followed by construction in geometry, faces, edges and vertices at more than 67% respectively.

Table 4.13 indicates the pre test results after teaching was done for two weeks. This established the effects on student performance on geometry after applying all methods. Both groups performance were compared.

Table 4.13 Pass rate in post test exam in control group (y) and treatment group (x) after teaching.
<table>
<thead>
<tr>
<th>Q no</th>
<th>Concept being tested</th>
<th>N</th>
<th>% Pass</th>
<th>N</th>
<th>% Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>sum of interior angles of a triangle</td>
<td>198</td>
<td>66</td>
<td>221</td>
<td>74</td>
</tr>
<tr>
<td>10</td>
<td>construction in geometry</td>
<td>170</td>
<td>57</td>
<td>206</td>
<td>69</td>
</tr>
<tr>
<td>9</td>
<td>properties of quadrilaterals</td>
<td>188</td>
<td>55</td>
<td>194</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>faces edges and vertices</td>
<td>165</td>
<td>53</td>
<td>200</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>Pythagorean relationship</td>
<td>153</td>
<td>51</td>
<td>185</td>
<td>62</td>
</tr>
<tr>
<td>6</td>
<td>angle properties in triangles</td>
<td>153</td>
<td>51</td>
<td>183</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>supplement and complement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Complimentary angles</td>
<td>141</td>
<td>47</td>
<td>171</td>
<td>57</td>
</tr>
<tr>
<td>1</td>
<td>bisecting and right angled triangle</td>
<td>129</td>
<td>43</td>
<td>173</td>
<td>58</td>
</tr>
<tr>
<td>7</td>
<td>angles on parallel lines</td>
<td>114</td>
<td>38</td>
<td>158</td>
<td>53</td>
</tr>
<tr>
<td>3</td>
<td>angle properties</td>
<td>87</td>
<td>29</td>
<td>123</td>
<td>41</td>
</tr>
</tbody>
</table>

Key: N – number of pupils, scoring, Y – control group no, X- treatment group no

The findings indicated that during pretest only one question in ten questions, sum of interior angles of a triangle had pass rate more than 50%. All the others had pass rate less than 50% in control group. In treatment group similarly the same was repeated with sum of interior angles of a triangle having 51%. Angles properties were the hardest concept followed by angles on parallel lines, bisecting and right angled triangle. The findings showed that after teaching both groups for two weeks using practical approach in treatment group and others preferred common methods by various mathematics teachers,
control group had six questions scoring more than 50% and four questions scoring less than 50%. These questions tested the following concepts, complimentary angles, bisecting and right angles triangle idea, angles on parallel lines and angle properties in a triangle. Treatment group had only one question scoring less than 50%. This question tested the concept angle properties. There was improvement in performance in both groups but treatment group had an upper hand. This indicated that practical approach had more effect on performance. Therefore there was a statistically significant more positive effect on performance in geometry questions when using practical methods than other methods.

The effect of practical teaching on performance in geometry in primary school in Thogoto zone was tested using standardized tests which results were subjected to paired t test. Table 4.12 indicates paired samples statistics in pretest and posttest among treatment and control groups.
One group was subjected to practical teaching method and considered as the treatment group while the other was taught using other common teaching methods. This was considered control group. The difference between the means was computed for both the control and treatment group. The difference between pre test and post test for treatment group was 1.9 with a lower limit of 1.6 and upper limit of 2.1 at 95% confidence interval. For the control group the difference between the means for pretest and post test was 0.3 with a lower limit of 0.1 and upper limit of 0.5 at 95% confidence interval.

Table 4.13 indicates the Paired Samples test differences. The difference between the means was computed for both the control and treatment group.

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment group</td>
<td>3.4147</td>
<td>5.2910</td>
<td>3.2809</td>
<td>3.5953</td>
</tr>
<tr>
<td>N</td>
<td>299</td>
<td>299</td>
<td>299</td>
<td>299</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>2.37194</td>
<td>3.05195</td>
<td>2.46479</td>
<td>2.43440</td>
</tr>
<tr>
<td>Std. Error Mean</td>
<td>.13717</td>
<td>.17650</td>
<td>.14254</td>
<td>.14078</td>
</tr>
</tbody>
</table>

Table 4.14 Paired Samples Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment group</td>
<td>3.4147</td>
<td>299</td>
<td>2.37194</td>
<td>.13717</td>
</tr>
<tr>
<td>Posttest</td>
<td>5.2910</td>
<td>299</td>
<td>3.05195</td>
<td>.17650</td>
</tr>
<tr>
<td>Control group</td>
<td>3.2809</td>
<td>299</td>
<td>2.46479</td>
<td>.14254</td>
</tr>
<tr>
<td>Posttest</td>
<td>3.5953</td>
<td>299</td>
<td>2.43440</td>
<td>.14078</td>
</tr>
</tbody>
</table>
Table 4.15 Paired Samples t -Test

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>T</th>
<th>Df</th>
<th>Sig.(2tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatme nt group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>1.9</td>
<td>2.4</td>
<td>0.14</td>
</tr>
<tr>
<td>Posttest</td>
<td>2.1</td>
<td>1.6</td>
<td>13.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>298</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest -</td>
<td>0.3</td>
<td>2.0</td>
<td>0.12</td>
</tr>
<tr>
<td>Posttest t</td>
<td>0.5</td>
<td>0.1</td>
<td>2.682</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>298</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.008</td>
</tr>
</tbody>
</table>

The difference between pre test and post test for treatment group was 1.9 with a lower limit of 1.6 and upper limit of 2.1 at 95% confidence interval. For the control group the difference between the means for pretest and post test was 0.3 with a lower limit of 0.1 and upper limit of 0.5 at 95% confidence interval. The critical value at p < 0.05 using 2-tailed t-table i.e. p (T > b) = α/2 with degree of freedom (df) = 298, b is 1.960 where α is infinity. The critical value at 10% significance level is 1.282, which is 10% in each lower
and upper tail. The critical value at 5% significance level is 2.326 and 2.576 at 1% significance level. So the null objective was rejected only at 10% significance level in favour of alternative objective.

There was a statistically significant effect on performance in geometry questions when using practical methods.

According to Mugo, (2010) a practical approach to geometry teaching ensures that learners interact with different activities which in turn lead to intellectual development of learners. Practical work motivates learners by stimulating interest and enjoyment. Learners retain more of what they learn by doing than what they learn by hearing.

4.5 Teachers’ and pupils’ attitudes towards geometry in primary schools in Thogoto zone.

The fourth task was to determine teachers’ and pupils’ attitudes towards geometry. Teachers were requested to suggest three ways of improving the teaching of geometry. Fifteen teachers responded as follows: 20% suggested use of teaching and learning resources, 40% teaching concepts in all levels and proper use of the syllabus, 20% use of practical, demonstration and discussion methods and 20% more practice on construction problems.

NTCM,( 2000) indicated that effective geometry teaching requires understanding what pupils know and need to learn, a challenging and supportive learning environment and continually seeking improvement. Teachers thought practical method took a lot of curriculum specific time while lack of tools was taken as a major cause of the method used, however teachers agreed practical method was an effective approach in teaching geometry. Teachers had a feeling that use of KICD syllabus and appropriate practical
method in geometry reduced misconceptions in geometry, however this method took 

<table>
<thead>
<tr>
<th>Ser. No</th>
<th>Attitudes of teachers on geometry teaching</th>
<th>SD</th>
<th>D</th>
<th>NS</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Geometry concepts are simple to teach in primary school.</td>
<td>7%</td>
<td>26%</td>
<td>7%</td>
<td>53%</td>
<td>7%</td>
</tr>
<tr>
<td>2</td>
<td>Practical teaching in geometry takes a lot of time</td>
<td>0%</td>
<td>20%</td>
<td>13%</td>
<td>47%</td>
<td>20%</td>
</tr>
<tr>
<td>3</td>
<td>Discussion method is easier than practical</td>
<td>53%</td>
<td>20%</td>
<td>7%</td>
<td>20%</td>
<td>0%</td>
</tr>
</tbody>
</table>

more curriculum specific time and hence avoided by many.

The study established attitude teachers had on certain aspects of geometry. A likert scale ranging from strongly disagree (SD) to strongly agree (SA) was used. Fifteen teachers responded to the questionnaire expressing their feeling towards geometry teaching.

Table 4.16 Attitudes of teachers on geometry teaching
Three fifths (60%) agreed that geometry concepts were easy to teach while 33% responded contrary. Sixty seven percent (67%) agreed that practical teaching took more time while twenty percent (20%) disagreed. A fifth (20%) agreed that discussion method was easier than practical teaching while seventy three percent (73%) disagreed. Twenty seven per cent (27%) agreed that lecture method was easier than practical teaching while seventy three per cent (73%) disagreed. Finally more than three quarters (79%) agreed that demonstration method was more commonly used to teach geometry while fourteen percent (14%) disagreed. The findings indicated that teacher’s preferred demonstration method than practical teaching as the latter took more curriculum specific time. Similarly teachers avoided discussion method for practical teaching. These findings supported SMASE, 2011 that teachers tend to use talk and chalk method rather than organizing practical activities in geometric conceptual development. According to Munyao, (2013) most African countries report that teaching is examination oriented and rote learning is more than practiced. According to Twoli, (2007) there are two main teaching strategies namely expository and heuristic. In expository, the teacher is the centre of all activities in the classroom. Learners memorize basic information and reproduce, leading to shallow learning. In heuristic approach the teacher only help the learner to find out by posing questions, guiding, indicating sources of information and sharing ideas, problems and solutions. This is a learner centered as the learner is
centre of most learning activities. In geometry both approaches can be used. The findings indicated that most Thogoto teachers preferred expository approaches such as demonstration and discussion. Thirty three per cent (33%) agreed that geometry concepts were not simple while seventy per cent (70%) felt they were. This was supported by pupils report on how teaching was done in class where pupils indicated that teachers used different teaching methods. Pupil’s responded on their liking to geometry teaching and learning by filling a questionnaire. A total of eighty seven (87) pupils gave their feeling as shown by table 4.17 below.

Table 4.17 Pupil’s attitude on geometry teaching and learning

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Percent</th>
</tr>
</thead>
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The findings indicated that four percent (4.6%) disliked geometry while eighty five (85.4%) liked it. Various reasons were given by pupils why they don’t like the topic. The reasons were as follows: 25% was due to lack of geometrical sets, 75% was due to language used, 25% was due to un taught lower levels content and 25% not taught at all. It was evident that pupils were challenged by language used while teaching geometry. Miano, (2008) indicated that learners retain more of what they learn by doing than what they learn through hearing. SMASE, (2013), nearly 23% of the recommendations were on provision of adequate and appropriate teaching and learning materials while 15% of the strategies were on use of appropriate learner-centered methodologies. Research
findings therefore showed that *there were negative and positive attitudes among teachers and pupils towards geometry teaching and learning in primary schools in Thogoto zone.*

4.7 Discussion of Findings
This section presents the discussion of the findings as sorted according to objectives together with findings from other studies that agree with findings of this study.

4.7.1 Extent to which primary mathematics teachers used practical teaching approach
An effective teacher should plan and use appropriate methods depending with the content. KICD, 2012 observed that different pedagogical approaches can be used to different learning outcomes. Thogoto mathematics teachers used all methods of teaching but preferred practical and discussion methods according to pupils. The findings indicated that most Thogoto teachers preferred expository approaches such as demonstration and discussion according to their responses. Teachers tend to explain and provide chalkboard illustrations at the expense of practical actions. Constructivism theory suggests that knowledge acquisition is better done through learner centered approach, hence need for practical method where learners learn by doing. According to Waihenya(2001) poor and inappropriate teaching methodology is one of the factors attributed to learners failure in mathematics.Mugo, (2010) emphasized that practical activities enhance the pupils’ understanding and also sharpen their creative skills. Practical teaching was used by many teachers however it was noted that teachers took demonstration as practical teaching as reported by pupils. This was evident that pupils were less involved. SMASE inset which involved primary mathematics teachers between 2007 and 2013 appeared to have improved teacher’s practical teaching methods in this
zone as it was noted during lesson observation. The study established that practical teaching methods were more preferred however teachers rarely discussed after teaching hence most lessons lacked conclusion. French, (2004) observed that pupils learn geometry notions and properties by exploring their environment. Pupils indicated that teachers used practical, outdoor activities and demonstration more than discussion, problem solving and project work. Geometry teaching therefore least considered real life situations of learners as problem solving and project methods were only used by thirty percent (30%). SMASE (2011) primary findings noted that teachers did not employ practical work in construction of models and angles. An accurate construction can be produced by proper use of required geometrical instruments such a pencil, a ruler, a pair of compasses, a protractor and a set square. NTCM, (2000) indicated that teachers are expected to prepare schemes of work, lesson plans and lesson notes and organize teaching learning activities and resources for effective geometry teaching. Forty seven per cent (47%) of teacher’s rarely improvised geometry related teaching and learning resources. Thogoto teacher’s preferred demonstration method than practical teaching as the latter took more curriculum specific time. Similarly teachers avoided discussion method for practical teaching. These findings supported SMASE, 2011 that teachers tend to use talk and chalk method rather than organizing practical activities in geometric conceptual development. According to Munyao, (2013) most African countries report that teaching is examination oriented and rote learning is more than practised. According to Twoli, (2007) there are two main teaching strategies namely expository and heuristic. In expository, the teacher is the centre of all activities in the classroom while heuristic approach the teacher only help the learner to find out by posing questions, guiding,
indicating sources of information and sharing ideas, problems and solutions. Heuristic is learner centered as the learner is the centre of most learning activities. Most Thogoto mathematics teachers preferred expository approaches such as demonstration and discussion however teachers agreed geometry concepts were not simple to teach while practical teaching took more curriculum specific time. Practical approach was used by experimental group however control group indicated that the method took more time and hence preferred demonstration where learners were least involved in practical activities, purely within the classroom. Practical method was thus avoided during geometry lessons to a larger extent.

4.7.2 Teaching learning resources used while teaching geometry

Thirty three per cent of teachers in Thogoto zone did not understand usefulness of teaching resources in geometry despite agreeing that teaching resources improves understanding of geometry concepts. In geometry the KICD syllabus recommends various teaching/ learning resources such as shapes, straight edges, rulers and pair of compasses, set squares, strings and ropes. These teaching resources were available and could have been improvised, however forty seven per cent of teachers felt resources were few. Constructivism theory suggests that knowledge acquisition is better done through learner centered approach, hence need for practical method where learners learn by doing. According to KIE, (2006) practical work motivates learners by stimulating interest and enjoyment however teachers are given leeway to improvise appropriate resources for effective teaching. Teachers failed to use the environment and even failed to improvise teaching/ learning resources available. There was no proper and appropriate use of resources and even geometrical tools in geometrical sets such as a pair of divider and
protractor. Teachers commonly used geometrical tools especially blackboard ruler and blackboard protractor, however pair of compass, pair of dividers and set squares was least used. Pupils agreed that lack of geometrical sets was a common problem. Paulucii, (1970) concluded that the teacher should learn how to select the materials carefully, preview and use them effectively. In geometry, various teaching/learning resources recommended for use include circular, rectangular and triangular shapes, rulers, pair of compasses, set squares, protractors, tape measures, strings and ropes. When resources are not readily available; teachers are advised to improvise and make good use of those materials that are affordable and available in their environment. Forty per cent of Thogoto teachers used teaching aids whereas forty seven per cent felt resources were few and therefore did little effort to improvise them. This contradicted behaviorisms theory where learners are viewed as passive and therefore need external motivation and reinforcement.

4.7.3 Effects of practical teaching on performance in geometry

Teaching and learning is done systematically using the syllabus which specifies the objectives of content to be taught and which must be related to the goals of education (KIE, 2002). There is need for the students to be active participants in the learning process for which responsibility for and ownership of learning is emphasized. One group was subjected to practical teaching method and considered as the experimental group (y) while the control group (x) was taught using preferred common methods. Each group was subjected to a pretest and a post test on geometry. Post test was administered after two weeks. The treatment group obtained a mean of 3.4 and 5.2 in pretest and posttest respectively while the control group obtained a mean of 3.2 and 3.5 in pretest and posttest respectively. There was positive change in posttest treatment group (1.9) than in posttest
control group (0.3) after teaching, proving that practical methods had positive effect on geometrical conceptual understanding. According to Twoli, (2007), a teaching learning strategy refers to the way in which content is organized and presented in an instructional process. The strategy used should facilitate the teacher in achieving the set instructional objectives in geometry teaching and therefore practical approach proved better than the other methods.

4.7.4 Geometrical spatial reasoning errors identified during geometry teaching

Effective geometry teaching requires understanding what pupils know and need to learn. Geometry assessment should enhance students' learning and also act as a valuable tool for making instructional decisions by furnishing useful information to both teachers and pupils (NTCM, 2000). A total of ten questions in geometry were tested to both experimental group and control group. In control group pretest exam only one concept ie sum of interior angles of a triangle had a percentage pass above 50%. The concepts with highest reasoning error were angle properties, bisecting and right angled triangle and angles on parallel lines. In post test there was an improvement in pass rate with six concepts having a rate above 50%. The concepts with highest reasoning error were angle properties, bisecting and right angled triangle and angles on parallel lines. In the treatment group pretest, concepts with highest reasoning errors and thus lowest pass rate were angle properties followed by angles on parallel lines, supplement and complement angles. Concepts on sum of interior angles had the highest percentage pass followed by properties of quadrilaterals and construction in geometry. In the post test exam in treatment group angle properties had the highest reasoning errors and least pass rate. All the other concepts had a pass rate above 50% with sum of interior angles of a triangle followed by construction in geometry, faces, edges and vertices. After teaching both
groups for two weeks using practical approach in treatment group and others preferred methods by various mathematics teachers, control group had six questions scoring more than 50% and four questions scoring less than 50%. These questions tested the following concepts, complimentary angles, bisecting and right angles triangle idea, angles on parallel lines and angle properties in a triangle. Treatment group had only one question scoring less than 50%. This question tested the concept angle properties. There was improvement in performance in both groups but treatment group improved more. According to Rolet, (1996) a practical approach to geometry teaching ensures that learners interact with different activities which in turn lead to intellectual development of learners. He explained that primary school curriculum distinguishes four classes for the concepts explicitly or implicitly present namely; basic objects like points, segments, lines and angles. Various errors were identified which included mostly construction misconceptions and measuring of angles. Major misconception errors were related to recognition of geometrical shapes, space figures, interior angles of a triangle, quadrilateral and drawing of nets. The research findings established various common spatial reasoning errors such as inscribing and circumscribing, measuring and constructing angles, space figures, and angles in triangles made agreeing with Mayberry, 1983 findings on misconceptions such as recognition of geometric shapes, solids, drawings of their nets and constructions.

4.7.5 Teachers and pupils attitude towards geometry
Teachers concluded that practical method takes a lot of time while lack of tools was taken as a major cause of the method used; however teachers agreed practical method was an effective approach in teaching geometry. Teachers felt use of KICD syllabus and
appropriate practical method in geometry may reduce misconceptions in geometry; however this method took more time and hence avoided by many.

Study findings indicated that four percent (4.6%) disliked geometry while eighty five (85.4%) liked it. Various reasons given why pupils don’t like the topic included, 25% was due to lack of geometrical sets, 75% was due to language used, 25% was due to untaught lower levels content and 25% not taught at all. It was evident that pupils were challenged by language used while teaching and learning geometry in Thogoto zone.
CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction
This chapter presents the summary, implications, conclusion, recommendations, policy recommendations and further research recommendations as observed from research findings on this study.

5.1 Summary of Study
The study was on influence of practical approach of teaching on student achievement in geometry in public primary schools in Thogoto zone, Kiambu County, Kenya. This study was guided by four objectives; to determine extent primary mathematics teachers used the practical teaching approach, to establish the resources used in teaching geometry, to establish effects of practical teaching on student performance in geometry and to determine teachers’ and pupils’ attitudes towards geometry.

Four research hypotheses were generated for this study based on extent of practical approach, use of teaching/learning resources, effect on student performance and teachers and pupil’s attitudes towards geometry teaching and learning.

The study sought to investigate influence of practical approach of teaching on student achievement in geometry in public primary schools in Thogoto zone, Kiambu County, Kenya

The study was guided by constructivism and behaviorism theory, which created a context for learning in which students became engaged in interesting activities that encouraged and facilitate learning. The study independent variable included practical approach in
learning geometry while dependant variable was performance in geometry among standard seven pupils. Intervening variables included time, attendance, curriculum and other teaching methods.

The study was based on quasi-experimental design. It was both quantitative and qualitative research. Cause and effect were established by use of casual comparative research. These gave base for research findings, conclusions and recommendations.

5.2 Summary of Findings
Findings from the study indicated that mathematics teachers within Thogoto zone used a variety of methods while teaching geometry with demonstration and discussion being the most commonly used and the practical method being the least used. It was evident from the results that teachers consider demonstration synonymous with practical teaching.

The study reveals that most teachers are not aware of the many resources available in the environment and hence do not improvise where there is lack of mainstream geometrical resources. This hinders effective teaching of geometrical concepts to learners. In addition, the study showed that there was general consensus among teachers in this zone that use of tools helps improve teaching of geometry. The study found out that set squares and pair of dividers were least used.

Practical teaching was noted to enhance pupil’s performance in examinations as compared to other teaching methods. According to the findings of this study there was a statistically significant relationship between use of practical approach and performance in teaching geometry in Thogoto zone. The study further noted that there was positive improvement in performance of both treatment and control groups. However, paired sample t-tests results indicated that there was a more positive effect in performance in
treatment groups that received pure practical teaching than the control group. The study shows that there was a statistically significant effect on performance in geometry questions when using practical methods in primary schools in Thogoto zone. Spatial reasoning errors were observed in all geometrical concepts that were tested. However, there were fewer reasoning errors on concepts relating to quadrilaterals as compared to those relating to incomplete shapes, construction and angles across all groups.

The research finding showed that teachers prepare schemes of work using KICD syllabus but they rarely prepare lesson plans which were followed in the real teaching exercise of geometry topics. This can be attributed to inappropriate understanding or lack of competence in geometry concepts. Teachers had a feeling that practical method takes a lot of time while lack of tools was a major determiner of teaching methods used. However, teachers agreed that practical method was an effective approach in teaching geometry. It was evident that pupils were challenged by language used while teaching and learning geometry in Thogoto zone.

5.3 Implications of the findings for practice
An effective teacher should plan and use appropriate methods depending with the content. KICD, 2012 observed that different pedagogical approaches can be used to different learning outcomes. Thogoto mathematics teachers had no specific methodology however same KICD syllabus content was used. Despite having attended SMASE inset that emphasized on learner centered approach, most mathematics teachers used demonstration and discussion methods.
Geometry lesson lacked improvisation, creativity, and application despite environment giving plenty of teaching/learning resources. These teaching resources were available and could have been improvised, however many teachers felt resources were few.

Specific objectives in KICD syllabus was not specifically followed while preparing schemes of work. Constructivism theory suggests that knowledge acquisition is better done through learner centered approach, hence need for practical method where learners learn by doing.

Thogoto mathematics teachers agreed that practical method takes a lot of time while lack of tools was taken as a major concern; however teachers agreed practical method was an effective approach in teaching geometry. Most mathematics teachers gave geometry to trainee and newly employed teachers, this conflicted effective teaching in geometry.

5.4 Conclusions:
From the findings of this study there were four conclusions. First, based on responses of teachers and pupils the use of practical method in teaching geometry was very low. While teachers use geometrical tools in their classrooms, there were very few outdoor activities that relate to day to day activities that can help learners to conceptualize concepts of geometry. What teachers considered as practical teaching was demonstration. Teachers thought demonstration was practical method, but since pupils were not involved in hands on activities, the methods lacked practical aspect.

Secondly, practical teaching was a more effective method of teaching than other classroom teaching methods. It yielded better performance. In practical teaching the
learners apply geometry concepts not only to solve examination questions but also in daily life activities.

Thirdly, geometrical concepts that relates to shapes are easily understood by pupils. However those involving angles and bisecting are least understood. High reasoning errors relating to angles and bisection could be due to limited exposure of learners to concepts of angles in day to day life.

Lastly, teachers and pupils had both positive and negative attitudes towards geometry teaching. Teachers lacked improvisation skills while pupils were affected by mathematical language in geometry.

5.5 Recommendations
This study classified its recommendation into two areas: policy recommendation and recommendations for further research

5.5.1 Policy Recommendations
The following are the policy recommendations arising from the findings of this study:

i. The ministry of education through the SMASE program i.e strengthening of mathematics and sciences program should target to incorporate practical teaching of geometry in primary schools. In addition to focusing on attitude change towards mathematics as a teaching subject, it should also target positive attitude toward practical teaching methods.

ii. Training of mathematics teachers should emphasize on practical teaching in geometry and improvisation of teaching and learning resources. This should be incorporated in the primary school teachers’ training curriculum.
iii. Mathematics teachers in primary schools within Thogoto zone need an in-service training on syllabus interpretation and applications of practical approach in teaching geometry content.

iv. The training should focus on enhancing teachers understanding of practical teaching and improving creativity of teachers in identifying practical activities to use to teach geometry.

v. There is need to assess attitude change in teaching of geometry in mathematics

5.5.2 Recommendations for further research

The researcher recommends that the following area be further researched:

(i) Consistency and accurate use of geometrical tools by mathematics teachers in teaching geometry. The fact that most teachers do not use Set Square warrants investigation into why they do not use them.

(ii) There is also need to establish why experienced teachers are ready to give newly posted teachers the mathematics subject.

(iii) Further study should investigate availability and adequacy of resources needed to teach geometry in primary schools. The study should focus on resources needed by learners and teachers for geometry classroom teaching.

(iv) Further study should investigate teachers’ attitude towards mathematics teaching.

The study should focus on attitude towards geometry teaching.
REFERENCES


Pittalis, M. (2010). *Students’ 3D geometry thinking profiles*, Lyon France: INRP


APPENDICES

APPENDIX I

Mathematics teaching topics given by TP schools – final TP 2012

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Sources: Teaching practice records, Thogoto T.T.C, 26/10/2012
APPENDIX II

Teaching practice survey on mathematics teaching topics

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Sources: Teaching practice records, Thogoto T.T.C, 26/10/2012
APPENDIX III
Thogoto zone public primary schools - 2014

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Sources: Kikuyu district office, Kiambu County - (KCPE 2012 data analysis)
APPENDIX IV

Map of Kiambu County

Standard 7 practical teaching activities in geometry
1. Using a straight edge or a string to show a straight line (180º).

2. Demonstrating parallel lines using straight edges such as timber, wires and also identifying angles formed.

3. Bisecting lines and angles by folding triangular and rectangular paper cut outs

4. Using a right angled paper cut out to classify angles such as obtuse, acute, reflex etc.

5. Use a right angled triangular cut out, form squares on each side, calculate areas formed and conclude the relationship \( a^2 + b^2 = c^2 \) where \( a \) and \( b \) are adjacent perpendicular sides.

6. Use a triangular cut out, cut interior angles, join them to form a straight line (180º)

7. Use papers cut outs of various quadrilaterals, identify their properties, cut the four interior angles and join them to form angles at a point (360º).

8. Use various constructed geometrical shapes such as triangular, rectangular and measure their sides and then construct their shapes on a paper.

9. Observing various patterns on walls, environment and forming similar geometrical patterns

10. Use space figures, identify their faces, edges and vertices and calculate their surface areas

11. Making nets and models of space figures such as cubes, pyramids, cuboids and cylinders.

12. Use triangular cut outs, identifying their interior and exterior angles, cutting and fitting them to discover opposite interior angles add up to one exterior angle.
APPENDIX VI

Standard 7, Thogoto Zone geometry quiz, 2014 (Post & Pre-Test)

You are requested to fill your details in the spaces provided. Work out the questions 1 to 5 and fill your answers in the spaces provided, question 6 to 10 circle the correct multiple choice.

TIME: 1 hrs.  DATE: -------------------------------

SCHOOL: ----------------------------------------------------------------------

CLASS: -----------------  SEX: ------------------------------------------
PLEASE ANSWER ALL QUESTIONS

Q1 The length of the two diagonals of a rhombus is 8cm and 6cm. What is the length of one side of the rhombus in cm?

Ans: _______________________

Q2 Calculate the total length of all the edges of the cube drawn below

Ans: _______________________

Q3 Find the value of angle marked e in the figure shown below. Line ABC is a straight line, AD = DB and angle ADB = 50°.

Ans: _______________________

Q4 Calculate the length CD of the combined right angled triangles shown below:

Ans: _______________________

Q5 What is the sum of supplement of 110° and compliment of 30°?

Ans: _______________________

Q6 In the diagram below AB = AC = BC and line AD is equal to line DC. What is the measure of angle BAD if angle ADC = 40°
Q7 In the figure below AB is parallel to CD. Angle OPR = 40° and angle ORP = 20°. What is the measure of angle AOP?

A. 140°  B. 60°  C. 70°  D. 130°

Q8 What is the measure of all the interior angles of triangle ABC shown below?

A. 60°  B. 140°  C. 40°  D. 120°

Q9 Which one of the following statements is TRUE for all quadrilaterals?

A. Opposite sides are equal
B. Diagonal bisect at right angles
C. Sum of interior angles is 360°
D. Interior angles are equal to 90°

Q10 Construct triangle JKL whose line JK = 6 cm, JL = 10 cm and angle JKL = 90°.

What is the length of line KL?

A16 cm  B 8 cm  C. 4 cm  D 5 cm

Thank you
APPENDIX VII

Standard 7 mathematics teachers’ questionnaire

SECTION A

The purpose of this questionnaire is to evaluate teaching of Geometry in primary schools in Thogoto zone. Please tick the appropriate response

1. What is your gender?
   Male ☐ Female ☐

2. What is your age?
   10-20 years ☐ 20-25 years ☐ 30-40 years ☐ 41-50 years ☐ 51 & above ☐

3. For how long have you been teaching mathematics in this school?
   1-4 years ☐ 5-9 years ☐ 10-13 years ☐ over 13 years ☐

4. Which class do you teach mathematics?
   Standard 6 ☐ standard 7 ☐

SECTION B:

Consider each of the following statements and indicate the response that reflects your opinion about teaching geometry by putting a tick (✓) in the appropriate column. Use the key:

0- Strongly Disagree  1- Disagree  2- Not sure  3-Agree  4- Strongly agree

<table>
<thead>
<tr>
<th>Item no</th>
<th>Attitude of teachers towards methods used in teaching geometry</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Geometry concepts are simple to teach in primary school.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Practical teaching in geometry takes a lot of time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Discussion method is easier than practical teaching in geometry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Lecture method takes less time than practical teaching

9. Demonstration method is more commonly used to teach geometry

**Use of teaching and learning resources**

10. Teachers use resources from the school environment to teach geometry concepts

11. There are very few geometry teaching and learning resources in the school

12. Teaching geometry is difficulty due to lack of relevant teaching/learning resources

13. Use of teaching/learning resources in teaching geometry improves understanding of concepts among pupils

**SECTION C**

Please fill the blank spaces with appropriate answers on your daily practice on teaching geometry

14. Do you prepare schemes of work for teaching geometry?

Yes ☐ No ☐

If yes what factors do you consider? Explain briefly

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

15. Do you prepare lesson plan for teaching geometry lessons?

Yes ☐ No ☐
16. When teaching geometry, which method or methods do you use? Tick appropriately.

Lecture □ demonstration □ discussion □ practical □

Outdoor activities □ Project □ problem solving □ others □

If others specify, _________________________________________________________

17. Do you use teaching / learning resources when teaching geometry concepts?

Yes □ No □

If Yes, mention them and if Not explain.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

18. Explain two common misconceptions made by pupils when learning geometry concepts___________________________________________________________

____________________________________________________________________
____________________________________________________________________

19. How do you rate your pupils’ performance in geometry?

Below Average □ Average □ Above average □ Good □ Excellent □
20. Suggest three ways of improving the teaching of geometry in primary schools.

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

21. Comment on use of the practical approach to teaching geometry concepts in primary schools.

__________________________________________________________________

Thank you for your co-operation
APPENDIX VIII

Standard 7 pupils Questionnaire

Please answer the given questions

1. What is your class? Standard ______________________

2. Do you learn geometry in your school? Yes ☐ No ☐

3. Do you like learning geometry? Yes ☐ No ☐

4. If Not, write down two reasons why you don’t like learning it

   (i) ___________________________________ (ii) _____________________________

5. The following are description of teaching methods that can be used in teaching geometry

   - Lecture method- teachers involved in giving ideas and no tools used
   - Demonstration – teachers use tools and activities are also done
   - Discussion- both teachers and pupils are involved in activities but this is purely within the classroom
   - Practical activities - both teachers and pupils are involved in geometrical activities. This is done in class and out of class. There is use of environment.

Which methods are used by your mathematics teacher when teaching geometry in your class?

Tick (✓) those used:

Lecture ☐ Demonstration ☐ Discussion ☐ Practical activities ☐

6. Which teaching materials are used by your teacher when teaching geometry? Name any four

   (i) _______________ (ii) ___________ (iii) ____________ (iv) ______________

Thank you for your co-operation
APPENDIX IX

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email:secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

Ref. No.

NACOSTI/P/14/2583/4253

Peter Gachoka Mwangi
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “An analysis of practical approach of teaching geometry in public primary schools in Thogoto Zone, Kiambu County, Kenya,” I am pleased to inform you that you have been authorized to undertake research in Kiambu County for a period ending 31st January, 2015.

You are advised to report to the County Commissioner and the County Director of Education, Kiambu County before embarking on the research project.

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

DR. S. K. LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
Kiambu County.

The County Director of Education
Kiambu County.

APPENDIX X

NACOSTI RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. PETER GACHOKA MWANGI
of KENYATTA UNIVERSITY, 0-902
KIKUYU, has been permitted to conduct
research in Kiambu County

on the topic: AN ANALYSIS OF
PRACTICAL APPROACH OF TEACHING
GEOMETRY IN PUBLIC PRIMARY
SCHOOLS IN THOGOTO ZONE, KIAMBU
COUNTY, KENYA

for the period ending:
31st January, 2015

Signature

Applicant's Signature

Secretary
National Commission for Science,
Technology & Innovation

Permit No: NACOSTI/P/14/2583/4253
Date Of Issue: 22nd December, 2014
Fee Received: Ksh. 1000
APPENDIX XI
INTRODUCTION LETTER

Kenyatta University
Department of Educational,
Communication and technology
P.O. Box 43844, 00100
Nairobi

The Head teacher

................................ Primary school

Dear sir/madam,

I am a post graduate student pursuing a master’s degree in Educational communication and technology at Kenyatta University. I am conducting a research on “influence of practical approach of teaching on student achievement in geometry in public primary schools in Thogoto zone, Kiambu County, Kenya.”

Kindly allow me to conduct this research in your school.

Thank you for your cooperation and assistance.

Yours faithfully,

Mwangi Peter Gachoka  E55/CE/25872/2011
APPENDIX XII

THOGOTO ZONE: STD 7 PRE TEST AND POST TEST TIME TABLE – 2014

<table>
<thead>
<tr>
<th>Test</th>
<th>Date</th>
<th>Starting time</th>
<th>Stopping time</th>
<th>Invigilator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test</td>
<td>6th Oct 2014</td>
<td>10.00 am</td>
<td>11.00 am</td>
<td>Mathematics Tr.</td>
</tr>
</tbody>
</table>

OBSERVATION AND INTERVIEWS

<table>
<thead>
<tr>
<th>Post test</th>
<th>Date</th>
<th>Starting time</th>
<th>Stopping time</th>
<th>Invigilator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post test</td>
<td>21st Oct 2014</td>
<td>10.00 am</td>
<td>11.00 am</td>
<td>Mathematics Tr.</td>
</tr>
</tbody>
</table>

NOTE:

(i) Observe punctuality and stick to the time given

(ii) Each pupil to receive one test paper, answers to be writing in pencil in the same paper

(iii) Pupils to be appropriately spacing to avoid cheating

(iv) Extra question papers to be handed back together with answer sheets

(v) Lesson observation during mathematics lessons. Each sampled teacher to be observed twice.