# THE EFFECT OF GEOMETER'S SKETCHPAD ON STUDENTS GEOMETRY LEARNING MOTIVATION AND PROBLEM SOLVING ABILITY

Abera Kotu

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This is to certify that this thesis prepared by Abera Kotu Wakjira, entitled: **The Effect of Geometer's Sketchpad on Students Geometry Learning Motivation and Problem Solving Ability**: and submitted in partial fulfillment of the Requirements for the degree of Masters of Education in Mathematics Education compiles with the regulation of the university and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

Examiner..Mekbib Alemu.....Signature.....Date.Jan.9,2015

Examiner..Mulugeta Atnafu.....Signature.....Date.....

Advisor.....Signature.....Date.....

Advisor.....Signature.....Date.....

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Chair of Department or Coordinator

Abstract

This study investigated Geometer's sketchpad (GSP) and students' geometry learning motivation and problem solving ability. In this study pretest-posttest quasi experimental design with non equivalent comparison group was used. Two groups of 9th grade were selected using purposive sampling based on their first semester mathematics achievement. The two groups were assigned as experimental group (n=68) and comparison group (n=65) using lottery method. During 4 weeks instruction, the Intervention group received instruction with the GSP while the other groups were taught with traditional paper-pencil instruction. Data of study were collected through Motivation Measuring Questionnaire (MMQ) containing two parts: Self Efficacy Measuring Questionnaire (SEMQ), Effort Measuring Questionnaire (EMQ) and Problem Solving Ability Measuring Questions (PSAMQ). The content Validity Indices (CVI) were .79, .84 and .83 for SEMQ, EMQ and PSAMQ taken in order. Moreover the internal consistence had Cronbach's alpha values of .873 and .902 for SEMQ and EMQ respectively. Data were analyzed using the paired samples t-test, independent samples t-test and regression analysis. Findings of the study indicated that there was no statistical significant difference between the Intervention and comparison groups prior to the treatment in both motivation and problem solving ability. But, there was statistical significant difference between the Intervention and comparison groups after the treatment in both motivation and problem solving ability. That is the Intervention groups showed better improvements than the comparison groups. For Intervention groups, the low achievers and medium achievers showed better improvement as compared to the high achievers. It is recommended that instruction in geometry should be supported with appropriate use of GSP in order to improve students' motivation and problem solving ability.

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## Acronyms/Abbreviations

| | |
|---|---|
| CG | Comparison Group |
| CRESST | Center for Research on Evaluation, Standards and Student Testing |
| CVI | Content Validity Index |
| EMQ | Effort Measuring Questionnaire |
| ES | Effect Size |
| FDRE | Federal Democratic Republic of Ethiopia |
| GSP | Geometry' Sketch Pad |
| HA | High Achievers |
| IG | Intervention Group |
| LA | Low Achievers |
| MA | Medium Achievers |
| MMQ | Motivation Measuring Questionnaire |
| MS | Mean of Squares |
| PSA | Problem Solving Ability |
| PSAMQ | Problem Solving Ability Measuring Questions |
| SEMQ | Self Efficacy Measuring Questionnaire |
| SS | Sum of Squares |

# CHAPTER ONE: Introduction

This chapter deals with Background of the study, statement of the problem, objective of the study, research questions and significance of the study.

## 1.1. Background of the study

Nowadays our world rapidly changes from time to time. We are living in a dynamic and ever changing environment. Science and Technology are more advanced throughout the world. For this advancement the role of mathematics is high. Geometry as a branch of mathematics also plays a great role in science and technology. As mathematics contributes to the development of science and technology, technology also contributes to the development of mathematics. Research findings in other countries show that computer plays an important role in educational context and therefore it is encouraged in mathematics class room (Phonguttha, Tayraukham and Nuangehelern, 2009). Goldenberg (2000) also suggests that, the power of new technologies is one of the strongest forces in the contemporary growth and evolution of mathematics and mathematics teaching. This means computers are used to raise the importance of certain ideas, problems and topics more accessible and also provide new ways to represent ideas; choices about content and the type of pedagogy used. There are various types of technologies in mathematics. One of these technologies is the Geometer's Sketchpad (GSP).According to Dimakos & Zaranis (2010), extensive research has been undertaken to study the effects of the use of Geometer's Sketchpad on geometry curriculum, pedagogy, and learning. Due to the significant role that GSP has, mathematics educators are encouraging to put the appropriate technology into effect at all grade levels, ability levels, and in different areas of content (Phonguttha, TayrauKham and Nuangehelern, 2009).

Eventhough there are various types of dynamic geometry software, this study focuses on the effect of using the Geometer's Sketchpad (GSP) on student's geometry learning motivation and students' problem solving ability.

Research findings also suggest that motivation plays an important role to enhance student learning and performance when learning with the help of technology because students learn the concepts in their own. In technology mediated environments, where students must take an active role in their learning by self directing, motivation is essential to learning and performance Lee (2000) in Gabriel (2008).More over; GSP is used to improve student interest, enjoyment engagement. Hull, Andrew and Brovery, (1999) concluded that the use of GSP software improves student interest, enjoyment and participating in geometry Study results showed that the integration of technology with the curriculum can improve students' motivation. This indicates that class room instructions should be supported with appropriate technology (Peterson, Bury and Middlestead, 2007).

The way students do mathematics is influenced with computer technology and the problems which are accessible to our students (Li, Ligh and Wills, 1997).This shows that computer technology and mathematics problem solving have strong relationship. In addition to this technology gives a chance to students in solving mathematical problems. Technology helps students become mathematical problem solvers and give them a chance to solve problems in real life situations rather than just doing routine problems (Dimakos and Zaran's, 2010).

Eventhough research findings show the impact of technology on motivation, there is still a gap in considering the effect of technology in general and GSP in particular in

motivation with respect to variables measuring learning motivation. Research findings also show that there is a relationship between GSP and students achievement (Almeqdadi, 2000).

Dimakos and Zaranis(2010) also suggested that technology enables students become mathematical problem solvers. Computer technology is greatly influencing the way we solve mathematical problems (Li,Ligh & Wills,1997).In solving mathematical problems we have to consider phases of problem solving skills. Again the researcher still sees a gap in considering theses phases when solving mathematical problems in technology mediated environments. In this research the researcher will explicitly consider the relationship between GSP and students' motivation with respect to motivation variables, GSP and students' problem solving ability, motivation and students' achievement, GSP and students problem solving ability and students problem solving ability and their achievement.

### 1.2. Statement of the Problem

It is well known that mathematics is crucial subject for the development of science and technology. It plays a vital role for our country development. Helping students to develop their motivation and problem solving ability. Eventhough it is the fact that mathematics is essential for economic development of society and applications in different fields of science, but from the researchers experience every year.

According to Ethiopian context, the education and training policy of FDRE (1994,) one of the general objectives is to develop the physical and mental potential and the problem-solving capacity of individuals. Moreover raising students' creativity, interest, to make education supportive tools for developing traditional technology and for utilizing modern

technology are among the specific objectives. In order to prepare a generation who is competent, have good skills, ability, positive attitude, ability to solve problems on their own, motivated to learn and become good citizen .On the other hand focus is given to mathematics and science education in our country to enhance the development of science and technology to compete with the modern world.

From the researchers teaching experience every year students in Chancho Abageda Secondary and preparatory school students' motivation to learn mathematics in general and geometry in particular as compared to other subjects is low and not few students fail to develop an adequate understanding of geometry concepts, problem solving skills and ability. Several factors can be mentioned for this problem. Among these teaching methods, absence of appropriate use of technology, problems related to curriculum design and preparations of text books can be mentioned. Among these factors the method of instruction should be given priority as it has the direct significant impact on students' motivation and problem solving ability and the teaching learning method is what is implemented in the class by the teacher. If these problems continue like this in the future, it is difficult to prepare a generation who is competent especially where the focus of attention is given to mathematics and science education there must be solutions to these problems and hence research is required.

### 1.3. Objective of the Study

Research findings indicate that instructions supported with appropriate use of GSP has a positive impact in improving students' motivation and problem solving ability. The purpose of this study was also to see whether similar results hold true or not in our country with particular reference to Chancho Abageda Secondary and Preparatory school.

Based on this the objective of the study was:

1. to investigate the impact of GSP on Students geometry learning motivation.
2. to investigate the impact of using GSP in geometry instruction on students problem solving ability.

### 1.4. Research Questions

The study answered the following questions.

1. What is the effect of using GSP in geometry instruction on students' geometry learning motivation?
2. What is the effect of using GSP in geometry instruction on students' problem solving ability?
3. What is the effect of motivation on students' problem solving ability?

### 1.5. Significance of the Study

One of the roles of quality education is to prepare students who are competent, motivated, able to solve problems on their own, have positive attitude, experienced to use technology in teaching-learning. To these end secondary school teachers have a great role to prepare students. The study conducted on GSP and students geometry learning motivation and problem solving ability may provide valuable information on how Geometer's Sketchpad (GSP) motivates students in learning geometry since students lack of motivation in learning geometry is problem as stated in the statement of the problem. It also helps to know GSP enhances students' engagement and self direct learning in solving geometrical problems because in self direct learning students learn by themselves by using mental investment and direct engagement in authentic tasks. The

teacher here does more of a facilitating task. This tells us how much problem solving ability is positively or negatively correlated with motivation .The study may provide valuable information on how student's motivation is related to students' geometry performance. That is it provides information on which achiever level (low, medium or high) the effect of motivation (self efficacy and effort) is more significant. It helps to know the relationship between problem solving ability and achievement. This means on which achiever levels the effect is more significant. It may also provide information on how much the integration of technology with geometry curriculum is important. Finally ,the study may serve as a reference and encourage other researcher who want to conduct further study in this area.

### 1.6. Delimitations of the study

It would vital if the study was conducted at higher scale which was beyond the capacity of the researcher. Moreover, the nature of the study is a quasi experimental study. The study was also limited to instruction with GSP even though there are different geometry softwares. Moreover, this study was focused on geometry part of mathematics, but studies could be done secondary school algebra. There may be other dependent variables .But; this study was limited to two dependent variables, motivation and problem solving ability.

### 1.7. Limitations of the study

Any research is never conducted without limitations. Likewise this research had limitations of which include the following.

1. **Students' exposure to technology**: Students' lack of prior experience in manipulating technology was one of the limitations in this study.

2. **Nature of subjects**. In quasi experimental design since subjects are considered as they are, it is difficult for the researcher to have control over all the intervening variables that are related to different behaviors of human being.

### 1.8. Definition of Terms

**Geometry's Sketch pad (GSP)**:- is an interactive and dynamic computer program that can be used to help students learn and understand geometrical concepts and principles.

**Motivation** can be defined as the satisfaction that students get from teaching-learning

**Geometry: -** is the branch of Mathematics that involves properties, Measurements, and relationships of points, lines, angles, surfaces and solids (Sarracco, 2005).

**Self efficacy:** Self-efficacy refers to the confidence students have in their abilities for success in a given task.

**Effort:** Effort is amount of time that students expend in solving mathematical problems established by their teacher

**Problem Solving Ability**: is a method of problem assessment levels and it is the mean for all problem solving sub skills so that one means score is reached for each sub skills assessments (Selcuk, Caliskan & Erol ,2008) .

# Chapter Two: Review of Related Literature

This chapter deals with the review of the related literature. It comprises of the concept of learning, learning motivation, problem solving ability, problem solving ability and motivation, geometry, geometry learning, technology in learning geometry, technology and learning motivation, technology and problem solving ability, GSP, Motivation and problem solving ability.

## 2.1. Learning

Learning can defined in different ways due to the fact that theorists have different outlooks to learning .Learning has been defined functionally as changes in behavior that result from experience or mechanistically as changes in the organism that result from experience (Houwer,Holmes & Moors,2013). In this section learned is defined from views of behaviorists, cognitivists and constructivist learning theory.

### 2.1.1. Learning from Behaviorist points of view

The implication of the behaviorists' theory of learning is for the development of instructional objectives based on students' motivation and problem solving ability. The views the learning process is change in behavior. Morrison, Ross & Kempt (2001) concluded that idea on behavioral objectives as they defined on instructional objectives written from behavioral perspective. In order for transmission of knowledge to be effective learning environment should provide routines of activities and it needs to have a clear goal, feedback and reinforcement mechanism (Green, Collines & Resinik,1996).As a result of this theory has its own contribution for motivation and problem solving ability.

### 2.1.2. Learning from Cognitivists points of view

According to cognitivists view, learning process is internal mental process including insight, information processing memory and perception, the purpose in education is to develop capacity and skills to learn better and the role of educators is structuring content of learning activities. In addition to this the cognitive approaches to learning have emphasised the assumptions of constructivism that understanding is gained through an active process of creating hypotheses and building new forms of understanding through activity. In school level educational researches, the influence of Piaget has been significant, in particular his assumption that conceptual development occurs through intellectual activity rather than by the absorption of information (Mayes &de Freitas, 2004).

### 2.1.3. Leaning from constructivists point of view

According to the constructivists point of view learning is constructed by the learner from their previous experience and the teacher is simply facilitating the instruction by enhancing students' motivation and problem solving ability. It is rather too simplistic to argue that constructivism has emerged directly from a cognitive perspective. In fact, in its emphasis on learning-by-doing, and the importance of feedback, it leans partly towards the behaviourist tradition. In its emphasis on authentic tasks it takes much of the situativity position. Moreover Piaget's (1970) as cited in Mayes &de Freitas(2004) constructivist theory of knowledge is based on the assumption that learners do not copy or absorb ideas from the external world, but must construct their concepts through active and personal experimentation and observation. In the constructivist view, which emphasises general conceptual understanding and thinking ability, the reasons for

disillusionment with didactic teaching are mainly empirical. In general in constructivist view, learning can be summarised as the learner actively constructs knowledge through achieving understanding, learning depends on what we already know, or what we can already do, learning is self-regulated, learning is goal-oriented and learning is cumulative (Mayes &de Freitas, 2004).

**2.2. Learning Motivation**

Motivation can be defined in different ways. It is desire for a student to engage in an activity out of interest or enjoyment (Lokie, 2011). Moreover; it is a psychological feature that arouses an organism to action toward a desired goal, the foundation of goal oriented behavior and one key element between failure and success (Chegini, 2007).

The motivation of students is an important issue in secondary school education, particularly owing to importance of academic performance in their professional and it is the element that leads students' attitude towards learning process (Afzal,Ali ,Khan & Hamid,2010) . It is believed that motivation is crucial for effective learning because motivated students perform better in their school grades and other achievement outcomes (Hornery, Craven, Seeshing and Ali, 2008). According to pintrich (2003) and schunk (1995), what students do and learn affects motivation and vice versa. Studies of various age groups in a variety of content areas support the idea that intrinsically motivated students perform better in the classroom (Barnard, 2010). Evidence suggests that these students, as well as students who receive autonomy-support from teachers to enhance their intrinsic motivation, perceive themselves to be more competent and have more interest in and enjoyment of material (Bernard, 2010). Likewise, Miserandino (1996) in Barnard (2010) finds that students with high perceived competence receive better grades

in some subjects. Those who are more intrinsically motivated are more involved and persistent, participate more, and are curious about school activities, whereas more extrinsically motivated students report feeling more angry, anxious, and bored at school and therefore tend to avoid school activities (Bernard, 2010). Again, more autonomous/intrinsically motivated students receive better grades than their extrinsically motivated peers (Bernard, 2010, p.6-7).Research findings show that learning motivation is measured by various variables. According to Garcia (1995), Garcia and Pintrich (1995), Nolen and Haladyna (1989), Pintrich and Blumenfeld (1985) as cited in Tuan, Chin and Shieh (2005), self-perceptions of ability, effort, intrinsic goal orientation, task value, self-efficacy, test anxiety, self-regulated learning, task orientation and learning strategies enjoyment and confidence are among the variety of motivational factors.

Research findings showed that instructors who care about students must realize that making a positive environment in which to teach and learn Mathematics may reduce performance, anxiety and encourage enjoyment in Mathematics Furner & Berman (2003) in Curtis (2006).Enjoyment of Mathematics measures how much students enjoy working with Mathematics and attending Mathematics classes (Curtis, 2006).Enjoyment of a subject is influenced by various factors. Among these factors are class room activities and the subject teacher. The nature of activities that happen during the lesson have a bearing on the overall enjoyment of the subject (Mogari, 2003).Students who came to enjoy mathematics increase their intrinsic motivation to learning and vice versa. Students are interested in what they learn and they achieve better if they like what they teach (Ma & Kishor, 1997) in Nicolaidou & Philippou (2012).

Confidence is another variable measuring motivation. Students who are successful in Mathematics have a set of attitudes and beliefs that direct their learning. They see Mathematics as a meaningful interesting and worthwhile subject. These students feel confident in working with Mathematics and are motivated to work at becoming better learner (NRC, 2001) in Curtis (2006).

On the other hand, in the CRESST model of problem solving developed by O'Neill & Schacter(1997) motivation also contains three components; self efficacy, effort and worry. This means self efficacy, effort and worry are common elements to motivation and problem solving. Moreover Weith & Burns (2005) concluded that under appropriate conditions motivation may help insight problem solving and contributes to the ability to solve problems. In CRESST model problem solving incorporates four elements; content understanding, problem solving strategies metacognition and motivation. On the other hand technology enhances students problem solving by understanding the ideas embedded in the problems and motivates them. They are motivated means they are more self efficacious and use full effort in leaning. Since worry sometimes triggers negative effects and the role technology observed so far, self efficacy and effort are strongly related to technology as compared to worry. Hence self efficacy and effort are the targeted variables measuring motivation.

### 2.2.1. How to Measure motivation

Different researchers measure motivation in different ways because they defined it differently. According to Telley & Fishbach, (2001) motivation is a psychological construct that cannot be observed or recorded directly and researchers measure motivation in terms of observable cognitive (e.g., recall, perception), affective (e.g.,

subjective experience), behavioral (e.g., performance), and physiological (e.g., brain activation) responses and using self-reports. Furthermore, motivation is measured in relative terms: compared to previous or subsequent levels of motivation or to motivation in a different goal state (Telley & Fishbach, 2001).

Conley &Karabenich(2006) also concluded that motivation plays a critical role in student learning and achievement and more over it is intimately related to the ways students think, feel, and act in schools. Since motivation is related to thinking, internal feeling and students act in school and cannot be observed/recorded directly, it is preferable if it is measured in questionnaire rather than interview and observation as they can express their feeling, thinking through questionnaire.

**2.3. Problem Solving Ability**

Problem solving is defined in different ways. Martin (2011) cited in Laterel (2000) concluded that problem solving is a relationship between a task and a student; and resumes effort as well as knowledge. Moreover in Laterel (2000), problem solving is viewed for three perspectives. These are views of principles and standards, views of Mathematics educators and views of Mathematicians.

According to principles and standards problem solving is "engaging in a task for which the solution method is not known in advance'' (laterell, 2000. P.2).Moreover problem solving and mathematics learning are inseparable. According to principles and standards, "problem solving should contribute to mathematics content knowledge (laterell, 2000)

According to mathematics educators the definition of problem solving is consistent with that of principles and standards. Mathematics educators defined problem solving as even though the solution method to a given problem reaches a solution, then it is a problem

solving. They give emphases to given problem to be a non routine nature. Beyond the non routine nature of the problem the solution path should be within reach of the students, there must be a need to find a solution, reasoning and knowledge must be used in the problem solving (Laterell, 2000).

Mathematicians view problem solving as the method in textbook in which the method to find solution to problem should be eliminated. According to many mathematics there must be depth process in order to consider it as problem solving. That is there must be the process of evaluating possible techniques, applying techniques, reaching a solution, checking the result for accuracy and without the solution in a coherent form.

Polya(1957) also identified four components of problem solving skills.

**Understand the problem**

This is the first phase solving mathematical problems. It tells us about:

- The unknowns, data, conditionins, and so on in the problem
- Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown?
- Drawing a figure and introducing the suitable notation.
- Separating the various parts of the condition.

**Devising a plan**

- It is the second phase in Polya problem solving. It deals with:
- Find the connection between the data and the unknown. Look at the unknown!
- Try to think of a familiar problem having the same or a similar unknown. Could you restate the problem? Could you restate it still differently? Go back to definitions.

- If you cannot solve the proposed problem, try to solve first some related problem.
- Could you imagine a more accessible related problem? A more general problem?
- A more special problem? An analogous problem or data, or both if necessary, so that the new unknown and the new data are nearer to each other?

**Carrying out a plan**

- This is the third phase Polya problem solving. It is about:
- Carrying out your plan of the solution, check each step.
- Can you see clearly that the step is correct?
- Can you prove that it is correct?

**Looking back**

- This is the last stage of the four stages. It talks about:
- Examine the solution obtained.
- Can you check the result? Can you check the argument?
- Can you derive the solution differently? Can you see it at a glance?
- Can you use the result, or the method, for some other problem?

Problem solving involves a step by step method of finding a solution to a problem. That means it has subscales by which it is measured. It is also possible to find the average of the means of these scores the subscales so that one can evaluate students level of problem solving to judge whether they are low problem solvers, average problem solvers and high problem solvers as individual difference always exists. This is what we call problem solving ability. Selcuk, Caliskan & Erol (2008) defined Problem solving ability as a method of problem assessment levels and it is the mean for all problem solving sub skills

so that one means score is reached for each sub skills assessments. Since the levels of problem solving are clearly indicated in polya's model the researcher uses this model.

### 2.3.1. How to Measure Problem Solving Ability

Measuring problem solving ability of students is not an end result rather it is a process and hence different researchers mention different instruments to measure problem solving ability. A rubric measure can be used to measure students' problem solving skills. This is supported by what Selcuk, Caliskan & Erol (2008) use in measuring students' performance assessment. Rubrics are tools that can help multiple instructors come to similar conclusions about construction of higher-level conceptual knowledge, performance skills, and attitudes and measuring a performance, a work product, or a learning skill can prove to be challenging without the appropriate measurement tool (Bargainnier, 2003). Angelo (2002), Bloom (1956), Anderson and Krathwohl, (2001), cited in Bargainnier(2003) also concluded that basic facts and concepts(declarative knowledge),can be measured with selected-response methods. But, Wiggins and McTighe, (1998), Angelo (2002) cited in Bargainnier(2003). Suggests that higher order thinking, procedural knowledge, and enduring understanding require more open-ended, complex and authentic types of assessment and evaluation (and Assessments and evaluations that require students to "construct" knowledge (called constructed response) cannot be scored easily with an answer key. When used for assessment, rubrics help both student and instructor identify strengths and areas for improvement in the learning process (Bargainnier, 2003).

## 2.4. Problem Solving Ability and Learning Motivation

Effort plays an important role in Mathematics problem solving. Song (2005) indicated that effort is one of the components that enable students to engage in the process of problem solving. Under appropriate conditions motivation may help insight problem solving and contributes to the ability to solve problems (Weith & Burns, 2005). Based on several problem solving models, O'Neil & Schacter (1997) developed the CRESST model of problem solving that incorporates four elements; content understanding, problem solving strategies, metacognition and motivation. This shows that motivation and problem solving ability have strong relation. In their model, motivation contains three components; self efficacy, effort and worry. Even though worry can trigger negative effects on learning, depending on the degree of worry, it could also contribute to positive antecedent to high achievement. It may trigger positive outcomes, in terms that it will drive students to work harder if their worries drive as a challenge to exhibit better performance (Yunus and Ali, 2009).

## 2.5. Geometry

The word 'geometry' comes from two ancient Greek words, one meaning earth and the other meaning to measure (Jones, 2002). Since the origin of geometry is very ancient, it is probably the oldest branch of mathematics with several ancient cultures developing a form of geometry suited to the relationships between lengths, areas, and volumes of physical objects. In these ancient times, geometry was used in the measure of land and in the construction of religious and cultural artifacts. Geometry is a wonderful area of mathematics to teach. It is full of interesting problems and surprising theorems. It is open to many different approaches. It has a long history, intimately connected with the

development of mathematics. It is an integral part of our cultural experience being a vital component of numerous aspects of life from architecture to design. What is more, geometry appeals to our visual, aesthetic and intuitive senses. Teaching geometry well can mean enabling more students to find success in mathematics (Jones, 2002).

### 2.6. Geometry Learning

According to the constructivists point of view learning is constructed by the learner from their previous experience (Mayes &de Freitas, 2004). They emphasize learning by doing. In order to understand ideas embedded in geometry problems the ways of teaching-learning plays a significant role. Geometry learning is the process of acquiring facts, skills, and methods the can be retained and used as necessary. Geometry learning is also interpreting and understanding geometric facts, concepts and figures in reality. Moreover, it is the process of acquiring facts, skills, methods, interpreting and understanding some geometric concepts such axioms, dimension, symmetry, measurements and constructions (Jones, 2002).

Teaching geometry well involves knowing how to recognize interesting geometrical problems and theorems, appreciating the history and cultural context of geometry, and understanding the many and varied uses to which geometry is put. It means appreciating what a full and rich geometry education can offer to learners when the mathematics curriculum is often dominated by other considerations. It means being able to put over all these things to learners in a way that is stimulating and engaging, and leads to understanding, and success in mathematics assessments. Nevertheless, despite the sheer complexity of learning to prove and the wealth of evidence suggesting how difficult it

can be for students, there are a few studies that show that students can learn to argue mathematically (Jones, 2002).

### 2.7. Technology in Learning Geometry

"One of the strongest forces in the contemporary growth and evolution of mathematics and mathematics teaching is the power of new technologies. In mathematics, computers have fostered entirely new fields. In education, they've raised the importance of certain ideas, made some problems and topics more accessible, and provided new ways to represent and handle mathematical information, affording choices about content and pedagogy that we have never had before"*(*Goldenberg, 2000, p1*)*.Technology help students to become mathematical problem solvers and give them a chance to solve problems in real life situations (Dimakos & Zaran's,2010).Geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures(Sarracco,2005).These shows that technology must be integrated into curricula in environments characterized by active learning, inquiry and problem-solving where higher order thinking skills are promoted. There are many types of technology software. Fathom Dynamic Data Software (Fathom), Tinker Plots Dynamic Data Exploration (Tinker Plots), Cinderella, and Geometer's Sketchpad are among these software (Awe, 2007).

#### 2.7.1. The Geometer's Skethpad

According to Jackiw (1997) defined Geometer's Sketchpad (GSP) as a popular commercial interactive geometry software program for exploring Euclidean geometry, algebra, calculus, and other areas of mathematics. Awe (2007) also concluded that is software that allows student so construct precise figures and manipulate them

interactively. Satterfield (2001) in Awe (2007) concluded that GSP helps students to develop mental models for thinking about geometric shapes and their properties.

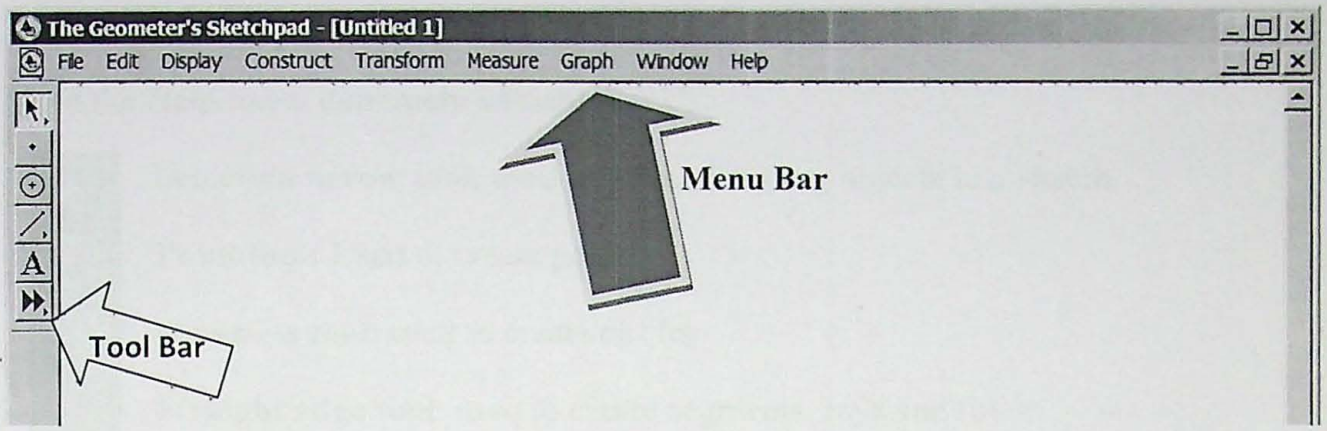



Fig.1.The GSP dialogue box with its menu bar and tool bar

**File menu**: contains the commands to open a new sketch, open a file, save a sketch, document options and print options

**Edit menu**: contains basic editing commands as well as Action Buttons command, which allows users to enhance the interactivity of the sketch

**Display menu**: contains commands for controlling the look of a sketch. A user can control the width of a line, the color of an object, hide or show objects, trace objects, and hide and show the text editing toolbar.

**Construct menu:** contains commands for constructing geometric objects

**Transform menu**: contains commands for transforming geometric objects.

**Measure menu**: contains commands for measuring geometric objects and the calculate command for performing calculations

**Graph menu:** contains commands for setting the type of grid, plotting points and functions, defining parameters, creating tables, and working with functions.

**Window menu**: contains commands that allow the user to control the appearance of the windows.

**Help menu:** provides access to Sketchpad's extensive help menu. Users will find the Help menu extremely valuable.



**Selection arrow tool**: used to select and drag objects in a sketch

**Point tool:** Used to create points

**Compass tool**: used to create circles

**Straight edge tool**: used to create segments, rays and lines.

**Text tool**: Used to display the labels assigned to objects and create captions

## 2.8. Technology and Motivation

Motivation is essential to learning and performance, particularly in technology-mediated environments where students must take an active role in their learning by being self-directed Lee (2000) as cited in Gabrielle (2008). The shift in education from an instructor-centered to a learner-centered focus requires learners to be self-directed and motivated. However, empirical data are lacking on how to positively affect self-directed learning. Further, the motivational needs of learners are often overlooked, and there is need for more literature examining both self-directed learning and motivation in technology-mediated learning environments (Gabrielle, 2008). Peterson, Bury and Middlestead (2007) pointed out that classroom instruction should be supported with appropriate technology because when correctly used, the integration of technology with the curriculum can improve students' motivation. Technology integration is an important part of any classroom, and when used correctly it can improve student's motivation.

Teachers must be able to match the correct technology with student's ability in order for the technology to be efficient and effective. Technology is available to teachers and should be used in the classroom. It is a tool that can help teachers plan lesson that are interactive, current, relevant and real and therefore motivating students (Peterson, Bury and Middlestead,2007).One of these technologies is the Geometers' Sketchpad(GSP). Using audio and video technologies brings content to life and stimulates learning. Boster et al. (2002) cites studies of teacher beliefs that multimedia presentations help increase interest, attention and curiosity. Teachers believed this increased attention led to increased retention and motivation, which ultimately led to better learning and improvement in student grades. A recent innovation for classroom use is streaming video accessible via the Internet. United streaming is an internet based video-on-demand application that gives students and teachers access to standards-based educational video clips. Because the use of video in classrooms has been proven to improve attention and motivation and appeal to students with different learning styles, Boster et al. (2002, 2004) conducted classroom experiments with united streaming and proved that the application enhanced educational performance. In addition to multimedia, educational software can positively impact student motivation, engagement and interest. Maushak et al. (2001) found that educational software can provide highly interactive technology that keeps students engaged within on stop actions, realistic sounds and vivid colors while providing educational instruction. Educational software disguised as games will capture and hold a students' interest. In support of the constructivist approach to learning, educational software can engage students to think and to learn. Stewart (1997) as cited by Maushak et

al. (2001) found that games can be effective instructional tools while motivating students (Reiners, Renner& Schreiber, 2005).

### 2.9. Technology and Problem Solving Ability

Students will be much more likely to appreciate the important role technology plays in their lives if they have been provided with the opportunity to become designers and solve technological problems( McCade ,2011).Wertheimer(1990) in DimaKos and Zaranis (2010) indicated that technology helps students become Mathematical problem solvers and gives them a chance to solve problems in real life situations ,rather than just doing routine problems. Branford et.al (1999) in Phongutthe, TayrauKham and Nuangehelern (2009) indicated that the use of computer technology makes educational contexts easier to create learning environments that enhance competences. The new technologies can help our students to draw difficult understanding and help to create an active problem solving environment (Phonguttha, TayrauKham and Nuangehelern, 2009).One of the advantages of GSP is its ability to allow students to explore geometric features without erasing or redrawing the figure. Automatic calculations can be done for angles, side length and ratio (Nordin, Zakari, Mohamed and Embi, 2010).The GSP software provides the process of teaching – learning Mathematics by a remarkable help because the power the GSP combined with the power of the proofs gives a complete illustrations of the theorem involved and the aspects of doing Mathematics ( Almeqdadi,2000). Computer technology is greatly influencing the way we do mathematics and the problems which are accessable to our students' .Many things which could not be done before now can be done easily with the help of computers (Li, Ligh and Willis, 1997). Studies indicate that high school student may not understand the

concept of geometry easily. "Learning geometry may not be easy and not few students fail to develop an adequate understanding of geometry concepts, geometry reasoning and problem solving skills" (Idris, 2007).

Geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures and will be able to analyze a problem by studying multitude of example(Sarracco, 2005).Moreover; software programs such as Geometer's Sketchpad (GSP) can certainly stimulate students', minds and motivate them to explore geometric theorems (Sarracco, 2005).Therefore; mathematics teachers should make use of this software resource as often as possible so that students are encouraged to go beyond just memorizing theorems and instead truly grasp the concepts( Sarracco, 2005) .

Instruction conducted in the Senior Secondary Schools today by traditional method shows that the mode of instruction does not stress real life application (Sule, 1997). This method of teaching does not provide the students opportunities for inductive and deductive reasoning (Sule, 1997). There is therefore the need to advance a variety of teaching methods, having to do with heuristic problem-solving, to Secondary School teachers of mathematics in order to promote positive attitude of students towards problem-solving in the Senior School Certificate mathematics (Sule, 1997). Traditionally, geometry instruction is augmented with the use of rulers, protractors, and compasses; however; GSP adds the possibility of new kinds of tasks and new ways of looking at old tasks (Ng & Teong, 2003). GSP can benefit students by enabling them to fully understand the ideas embedded in the theorems and problems (Pandiscio 2002). Problems are usually solved by giving many rules and features about the subject in primary and

secondary school geometry classes, the courses are tried to be processed from ragged drawings, and these drawings even confuse the right feelings of the students (Kesan & Caliskan, 2013). Since geometry is the study of shapes and space, it is taught through a variety of representations, such as diagrams, schemes, drawings, and graphs. These representations are a contextual description of geometrical concepts or ideas and may support the process of conceptualization (Mehdiyev, 2009). That is, the use of multiple representations facilitates students' development of geometrical concepts. Traditionally, geometry is taught and learned in a pencil and paper environment. Geometry textbooks at schools provide the above described illustrations. However, sometimes textbook-based illustrations may not be comprehensive, because they lack the visual description of a complete dynamic process needed for the construction of geometrical concepts. This incompleteness arises from the static feature of a textbook medium. In a textbook environment, a dynamic visualization of geometrical figures or shapes is left for an internal (mental) process. To be more explicit, students have to create dynamic geometrical constructions in their minds since a textbook depicts only ideal states of shapes. Such textbook descriptions do not explicitly picture the construction processes, through which the figures or shapes are idealized. The pencil and paper work only shows the result of the whole construction process, although this process is a product of mental performance (Mehdiyev, 2009).

### 2.10. GSP, Motivation and Problem Solving Ability

The Geometer's Sketchpad is a popular commercial interactive geometry software program for exploring Euclidean geometry, algebra, calculus, and other areas of

mathematics. It was created by Nicholas Jackiw(1995). Geometer's Sketchpad includes the traditional Euclidean tools of classical geometric constructions; that is, if a figure as the can be constructed with compass and straight-edge, it can also be constructed using GSP. Objects can also be animated. The program also allows the determination of the midpoint and mid segments of objects.

Geometer's Sketchpad also allows one to measure lengths of segments, measures of angles, area, perimeter, etc. Some of the tools one can use include; construct function, which allows the user to create objects in relation to selected objects. The transform function allows the user to create points in relation to objects, which include distance, angle, ratio, and others. With these tools, one can create numerous different objects, measure them, and potentially figure out hard-to-solve math problems. The GSP is one of the dynamic geometry software system for creating ,exploring analyzing a wide range of Mathematics concepts in the field of algebra, geometry ,trigonometry, calculus and other areas.(Johari,Ramli Chan &Ahmat,2010).The use of GSP software improved student interest and enjoyment and participating in geometry (Hull, Andrew and Brovey,2005). DimaKos and Zaranis (2010) showed that technology motivates students to be more interested in exploring , investigating , conjecturing creating , and discovering principle and making generalizations "We presented several learning experiences that illustrate how the pupils involved in this study developed the three aspects of the geometric competence, constructing and analyzing properties of figures, identifying patterns and investigating, and geometric problem solving. The teaching unit was based on three decisive elements: the dynamic geometry software, the tasks proposed, and the way how the pupils worked in the classroom. The use of GSP is an important support to the pupils'

constructions and discoveries, and its functionalities allowed them to develop the recognition of properties and the analysis of figures. Dragging a geometric construction and verifying what stays invariant and the possibility of trying many cases allowed them to investigate and solve the proposed geometric problems. All tasks are well accepted by the pupils, in particular the exploration and investigation ones. Their open nature allows pupils to get involve actively in their learning and developed the skill to search for invariants. To solve geometric problems, they used constructions. The justifications that the pupils gave to conjectures that they elaborated, their solution processes and the way they improved strategies until they managed to solve a certain problem are aspects that reflect the challenge created by these kinds of tasks.

Technology promoted and effective tool to teach and learn geometry and one of the important vehicles of technological enhance in geometry classroom is the use of Geometer's Sketchpad (Phonguttha, TayrauKham and Nuangehelern, 2009). Habre and Grunmeier (2007) in Phonguttha, TayrauKham and Nuangehelern (2009) show that GSP can enhance students understanding or will enhance the pedagogical process. (Detuk, 1993, Jackiw, 1995 and Ruthven,2008) in Wilson(2011) pointed out that GSP provides immediate feedback motivates students to think mathematically and engages student. 'Geometer's Sketchpad "allow students to construct precise figures and manipulate them interactively" (Awe, 2007, p.15). GSP provides accurate constructions and measures of geometric configurations of points, line segments, circles, etc. and it has the ability to replay a given construction. The software can be used to provide visually compelling evidence of invariance properties such as concurrence of lines, the co linearity of points, or the ratios of particular measurements. In addition, Sketchpad allows translations,

rotations, reflections and dilations of geometric constructions to be made either singly or recursively, permitting the study of transformations in a visually compelling way.

## 2.11. Summary

In this section the ideas described in the literature review are summarized. It includes the summary of the subtopics: learning, learning motivation, problem solving ability, geometry, geometry learning, technology and GSP.

The definition of learning is included in the literature review. Learning can be defined in different ways due to the fact that theorists have different outlooks to learning and behaviorists, cognitivists and constructivist defined leaning from their perspectives. Learning can be defined functionally as changes in behavior that result from experience or mechanistically as changes in the organism that result from experience (Houwer,Holmes & Moors,2013). Students' motivation plays a great role for the process of learning to be effective. This is supported by the idea that motivation is crucial for effective learning because motivated students perform better in their school grades and other achievement outcomes (Hornery, Craven, Seeshing and Ali, 2008). The motivation of students is an important issue in secondary school education, particularly owing to importance of academic performance in their professional and it is the element that leads students' attitude towards learning process (Afzal,Ali ,Khan & Hamid,2010) .There are a number of variables that measure motivation .But for this particular study self efficacy and effort are the critical variables that relates motivation, problem solving ability and technology. On the other hand motivation and problem solving have strong relationship. Problem solving involves a step by step method of finding a solution to a problem. That means it has subscales by which it is measured. It is also possible to find the average of

the means of these scores the subscales so that one can evaluate students' level of problem solving to judge whether they are low problem solvers, average problem solvers and high problem solvers as individual difference always exists. This is what we call problem solving ability. Selcuk, Caliskan & Erol (2008) defined Problem solving ability as a method of problem assessment levels and it is the mean for all problem solving sub skills so that one means score is reached for each sub skills assessments. Since the levels of problem solving are clearly indicated in Polya's model the researcher uses this model. In order to understand ideas embedded in geometry problems the ways of teaching-learning plays a significant role. Geometry learning is the process of acquiring facts, skills, and methods the can be retained and used as necessary. Geometry learning is also interpreting and understanding geometric facts, concepts and figures in reality. Technology help students to become mathematical problem solvers and give them a chance to solve problems in real life situations (Dimakos & Zaran's,2010).Geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures(Sarracco,2005). Motivation is essential to learning and performance, particularly in technology-mediated environments where students must take an active role in their learning by being self-directed Lee (2000) as cited in Gabrielle (2008). The shift in education from an instructor-centered to a learner-centered focus requires learners to be self-directed and motivated. Students will be much more likely to appreciate the important role technology plays in their lives if they have been provided with the opportunity to become designers and solve technological problems( McCade ,2011).Wertheimer(1990) in DimaKos and Zaranis (2010) indicated that technology helps students become Mathematical problem solvers and gives them a chance to

solve problems in real life situations. Based on the ideas in this summary self efficacy and effort are critical variables measuring motivation and problem solving ability and can be summarized in the following diagram.

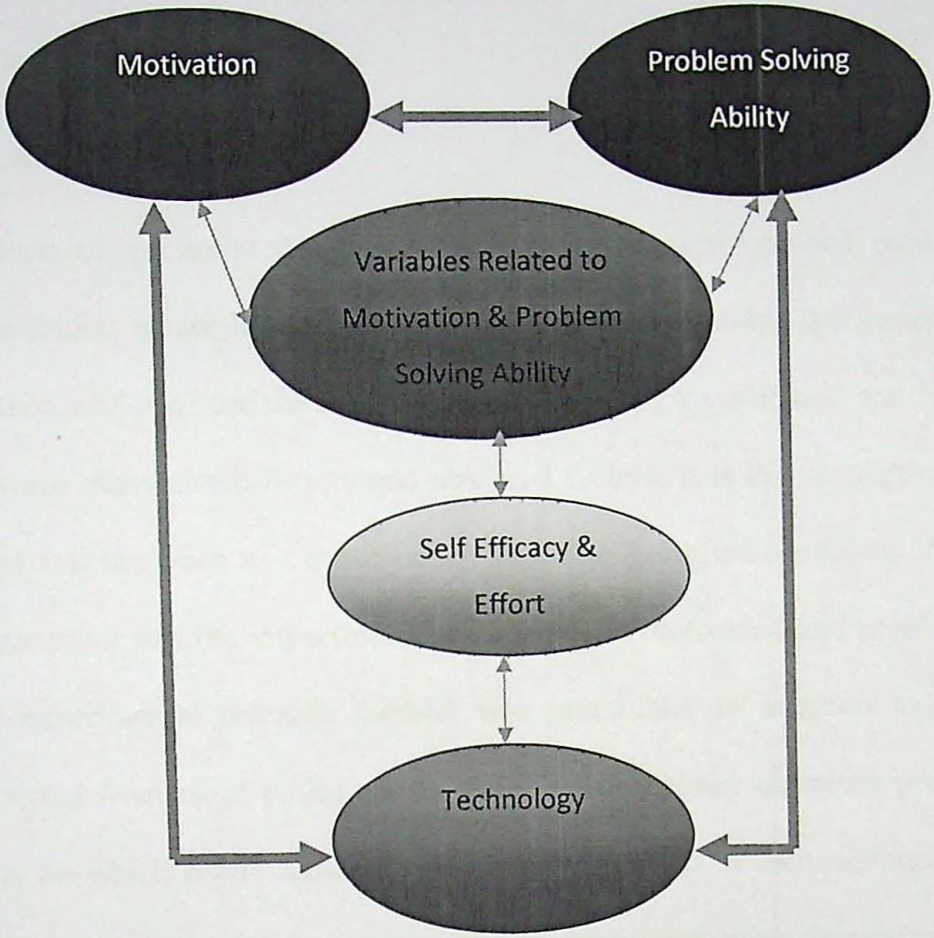



Fig. 2.Relationship between Motivation, Problem Solving Ability, technology and variables measuring motivation.

# Chapter Three: Method of the Study and Design

This chapter deals with method of the study, data source, sample and sampling techniques, data gathering tools, pilot test of the study, data collection procedure and method of data analysis.

## 3.1. Method of the Study

Method of the study deals with the type of research method used, qualitative and quantitative research methods. For this particular study, the experimental research method was used for the reason that it establishes a systematic and logical association between manipulated factors and observed factors. It is the description and analysis of what will be, when will occur under carefully controlled conditions. Moreover the title under study was the impact of GSP on students' motivation and problem solving ability the experimental research method was preferable. In addition to these, data were collected from close ended questionnaire and multistep questions prepared to measure PSA on which rubric measure e were applied. Both of them involved numerical data. These data were recorded; analyzed and interpreted using numerical data. Hence the quantitative research method was used.

## 3.2. Design of the Study

The design of the study is used to know how the treatment will be applied to intervention group and how the comparison group is compared with the intervention group and guide how to conduct the study. The pretest-posttest design was required for the intervention group to know the effect of the intervention. This could be done by adding a non equivalent comparison group, where students are considered as they are without random

assignment. The pretest is required for both groups before the intervention in order to have some idea on how similar or different the two groups are. Similarly, the posttest is required to know the effect of the intervention. This means the quasi experimental pretest-posttest design was used. There were one intervention and one comparison groups. The intervention group received the instruction with Geometer's Sketchpad and the comparison group received only the traditional paper-pencil instruction. Treatment took four weeks on the concept of areas of triangles and parallelogram by giving instruction for comparison groups using traditional method and intervention groups using GSP by the same teacher.

### 3.3. Participants of the Study

This study was conducted at Chancho Abageda Secondary and Preparatory School.
It is a governmental school located in Oromia Special Zone surrounding Finfinne,Sululta woreda. The researcher chose the school because he is working there. For this study the researcher considered grade 9 students for the reason that the time to teach grade 9 geometry was convenient as compared to grade 10 geometry. There were 769 grade 9 students with 422 male students and 347 female students. There were 10 sections of grade 9 students of at Chanco Aba geda Secondary and Preparatory School. The researcher considered two naturally assembled groups (two sections) as intact classes. The two sections (groups) that were equivalent in their means and standard deviations were selected out of 10 sections using purposive sampling. One of the two sections was randomly assigned as treatment group and the other as comparison group. The intervention group consisted of 68 students and comparison group consisted of 65 students .This purposive selection of equivalent groups using purposive sampling enabled

the researcher to know the effect of the intervention very well. Students in both groups were also classified as lower achievers, medium achievers and higher achievers based on their first semester mathematics results of the academic year taking ministry of education achiever level standards into consideration. Students who scored less than 50, between 50(inclusive) and 75 exclusive, and greater or equal to 75 were considered to low achievers, medium achievers and high achievers respectively. Asefa Enno(2004) in Eyasu Gemechu(2012) also states that this range of achiever level.

### 3.4. Data Collection Instruments

#### A .Motivation Measuring Questionnaire (MMQ)

For this particular study Motivation Measuring Questionnaire (MMQ) had two parts: Self Efficacy Measuring Questionnaire (SEMQ) and Effort Measuring Questionnaire (EMQ) based on the two motivation variables self efficacy and effort. Self Efficacy Measuring Questionnaire (SEMQ). The self efficacy items were taken from Betz's and Hacke's(1981) questionnaire with slight modification made by the researcher .Items were rated on a five point Likert- scale type,1=Strongly Disagree to 5=Strongly Agree and consisted of 14 items in which half of the items were positively worded and half negatively worded so that students can evaluate each items on its own rights and because if every item is worded in the same way students seem to evaluate them equally. Similarly effort items were taken from Agbuga (2010) with slight modification made by the researcher. It is a seven point likert scale type consisted of 8 items in which the level of agreements were ranged from 1=not at all true to 7=very true.

**B. Problem Solving Ability Measuring Questions (PSAMQ)**

In order to measure students' problem solving ability, open ended questions involving multi steps were developed by the researcher. These questions were taken from text books and references and subjected to pilot test. Students' problem solving ability was measured at each Polya stages (understanding the problem, devising a plan, carrying out a plan and looking back). Each Polya stage was accompanied with four scale lengths of rubric measure (0, 1, 2, & 3).That is students problem solving ability was seen at each Polya stages using performance assessment rubric. The point 0 was given if students can give no response, the point 1 was given if students respond but all inappropriate, the point 2 was given if students respond but miss most part and the point 3 was given if students respond complete and appropriate answers to the given problem.

### 3.5. Validity and reliability of the instruments

Validity is the extent to which the instrument measures what it supposed to measure. Content validity was made to check whether the content of the questionnaire is appropriate and relevant to the research under study and how much it is relevant to the conceptual framework developed. The content relevance of the questionnaire and problem solving ability measuring questions was made by using a four point Likert scale type 1 = not relevant, 2 = item need some revision, 3 = relevant but need minor revision,4 = very relevant The scale neutral is omitted to avoid ambiguity of items. According to Lynn (1996), cited in Parsia(2009),the Content Validity Index (CVI) is used to estimate the validity of the items and a rating of three or four indicates the content is valid and consistent with the conceptual framework. From this the formula used to find CVI can be induced as

$$CVI = \frac{Number of\ experts rated item as relevant (3 or 4)}{Number of\ experts participated}$$

According to Tilden, Nelson and May (1990) as cited in Rico, Dios and Ruch (2012), a general criterion for the content validity index of items should be ≥.70. Four mathematics teachers teaching grade 9 were involved to measure the content validity of the instruments during pilot test of the instruments and the result for CVI of SEMQ,EMQ and PSAMQ were .79,.84 and .83 respectively.

Face validity is used to check the appropriateness of the questionnaire to the study purpose and content area as it evaluates the appearance of the questionnaire in terms of feasibility, readability, consistency of style and formatting, and the clarity of the language used (Parsian, 2009).In this particular study face validity of the instrument was made by showing the instruments to mathematics and language teachers.

Another measure of validity was the construct validly to measure the dimension of the questionnaire. To this end factor analysis was used to measure the construct of a self efficacy and effort items to get a support on self efficacy and effort items on the assumption that students self efficacy in learning geometry has one factor solution (measure one dimension) and the effort items measure one dimension. Each items of SEMQ and EMQ had factor loadings ≥.30 and according to the conventional rule for factor loadings all values ≥.30 were accepted.

Once the validity of the instruments were checked the next step was to evaluate internal consistence of items to measure how items were geared together. Alpha's Cronbach was used to measures the internal consistence of items as it is the most commonly used to measure internal consistence of items and the coefficient of reliability of SEMQ (13 items) was .873 and EMQ (8 items) was .902 which were in acceptable range of

coefficient of reliability and consistent with what George & Malley(2003) cited in Gliem and Gliem(2003) concluded about the set the criteria for the coefficient of reliability, α. They concluded that α values 1.0-.9-excellent, .9-.8-good, .8-.7-acceptable, .6-.7-questionable, .5-.6-poor and <.5-unacceptable coefficient of reliability.

### 3.6. Data collection Procedure

Once SEMQ, EMQ and PSAMQ instruments were developed and pilot tested, the next step was to collect data to undertake the study. To this end, both questionnaire (SEMQ & EMQ) and PSAMQ were administered as a pretest to both groups to get information on students self efficacy, effort and problem solving ability a week prior to the intervention. Then after, the same instruments were given to both groups a week after the treatment had completed to see whether there was a difference between the groups as a result of the different teaching methods. More over PSAMQ were given first and followed by MMQ both in pretests and posttests.

### 3.7. Instruction and Instructional Materials

During the four weeks of instruction, instructional materials were essential to conduct this research. Therefore the researcher prepared based on the mathematics syllabus, Computers in the lab on which GSP software loaded on, Laptop, LCD projector and lesson plans on the concept of geometry. Regarding instruction, the CG were taught using traditional paper-pencil instruction and the IG were received instruction using GSP. The intervention groups were introduced about the GSP software. Then instructions were first given by the teacher on areas triangles, areas and perimeters of sectors, areas and perimeters of segments. Activities were given to students so that they can do activities using GSP on their own. Finally after the instruction was completed geometry problems

and questionnaire measuring motivation were given to both groups. At this time the Intervention group did geometry questions without GSP.

### 3.8. Variables of the Study

#### A. Independent Variables

Independent variables are variables which are manipulated by the researcher. It is often called the treatment variable or antecedent variable. The independent variables for this particular study were teaching with Geometer's Sketch pad and traditional paper-pencil instruction.

#### B. Dependent Variables

Dependent Variables are the conditions, or characteristics that appears, disappears or changes as the researcher introduces, removes or changes. Students' motivation and Students problem solving ability were dependent variables for this study.

### 3.9. Method of Data Analysis

The main purpose of this study was to know the between GSP and students geometry leaning motivation and problem solving ability of Chanch abageda secondary school students. It also with analysis and interpretation of the data collected from the respondents through the questionnaire measuring motivation and problem solving ability measuring questions. The pretest-posttest of the scores and standard deviations of the experimental and comparison groups were evaluated using independent samples t-test and the improvement in motivation and problem solving ability from pretest to posttest within the same group was calculated using the paired samples t-test. Analysis of variance was used to measure self efficacy, effort and problem solving ability with respect to the three achiever levels. Moreover, regression analysis was also used to know

the effect of self efficacy and effort on students' problem solving ability. More over to know the effect of the treatment Cohen's effect formula was used. According to Cohen(1988),the effect size of .2 and less is a small effect, greater than .2 and less or equal to .5 is modest effect, greater than .5 and less or equal to .8 is moderate effect, greater than .8 and less or equal to 1 is a large effect and greater than 1 is strong effect. Data collected from SEMQ, EMQ and PSAMQ were analyzed using SPSS version-20.

## CHAPTER FOUR: Data Analysis and Interpretation

This chapter deals with presentation, analysis and interpretation of the results obtained from the data. Data collected through instruments were analyzed using the paired samples t-test, the independent samples t-test, analysis of variance, regression analysis and Cohen's effect size formula. The main results obtained from statistical tests were tabulated, interpreted and also compared with the review of the literature for their validity.

To this end comparison of the two groups for their previous mathematics achievement to see how similar or different the two group in their previous mathematics achievement. The independent samples t-test was used to compare the significant differences of the two groups in their previous mathematics achievement and results were presented in table 4.1.

**Table 4.1**.Comparisons between experimental and comparison groups for previous achievement

| *Achievement Levels* | *Groups* | *N* | *M* | *SD* | *df* | *t* | *P* |
|---|---|---|---|---|---|---|---|
| LA | IG | 10 | 43.7 | 5.4 | 16 | .031 | .976 |
| | CG | 8 | 43.63 | 4.9 | | | |
| MA | IG | 50 | 61.84 | 6.55 | 97 | -.157 | 876 |
| | CG | 49 | 62.04 | 6.20 | | | |
| HA | IG | 8 | 82.75 | 8.9 | 14 | .118 | .908 |
| | CG | 8 | 82.25 | 8.01 | | | |
| Total | IG | 68 | 62.76 | 19.54 | 14 | .008 | .994 |
| | CG | 65 | 62.64 | 19.34 | | | |

Independent samples t-test was used to know whether there is a significant difference between the three achiever levels in previous achievement.

The independent samples t-test analysis for previous mathematics achievement for both groups indicated no significant differences in achievement at all achiever levels before

the intervention .This shows that the groups were equivalent in their previous mathematics achievement at the same level of achievement.

It was vital to compare the mean difference of each group of LA prior and after the intervention in order to see whether there was significant improvement or not in self efficacy and effort with respect to LA. To this end the paired samples t-test was used to evaluate the improvement within the same group from pretest to posttest. Moreover in order to know the magnitude of the effect of the treatment was evaluated using Cohen's effect size and results were presented in table 4.2.

**Table 4.2**. Self efficacy and effort pretest-posttest comparison for the Intervention and comparison LA

| | | | *Pretest* | | *Posttest* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Variables* | *Groups* | *n* | *M* | *SD* | *M* | *SD* | *t* | *P* | *ES* |
| Self Efficacy | IG | 10 | 2.01 | .14 | 2.77 | .66 | -3.644 | .005 | 1.59 |
| | CG | 8 | 2.07 | .094 | 2.12 | .108 | -1.667 | .140 | |
| Effort | IG | 10 | 3.06 | .53 | 3.63 | .63 | -3.737 | .004 | 1.09 |
| | CG | 8 | 3.09 | .265 | 3.08 | .258 | .552 | .598 | |
| Total | IG | 10 | 2.54 | .34 | 3.2 | .65 | -3.6905 | .0045 | 1.46 |
| | CG | 8 | 2.58 | .18 | 2.6 | .18 | -1.115 | .369 | |

The paired samples t-test was used to test the differences between the pretest and posttest of each group with respect to motivation elements: self efficacy and efforts for this particular study. Statistical analysis of the paired samples t-test in table 4.2.above results indicates that the means and standard deviations were M=2.01, SD=.14 in the pretest and M=2.77, SD=.66 in the posttest. Moreover ;( $t(9) = -3.644$; $p<.05$).This shows that the differences from pretest to posttest for intervention group were statistically significant for self efficacy. But, no statistically significant differences between pretest-posttest for comparison groups for self efficacy since $t(7) = -1.667$; $p>.05$. This means instruction with the GSP has a significant impact in improving students self efficacy in leaning

geometry and the comparison group taught with traditional GSP showed no significant difference from pretest to posttest in developing self efficacy The effect size d=1.59 shows a strong effect according to Cohen. This means instruction with the GSP had greatly increased the mean scores of self efficacy of the lower groups of IG.

Table 4.2. also presents, means and standard deviations as M=3.06, SD=.53 in the pretest and M=3.63, SD=.63 in the posttest and t (9) =-3.737, p<.05 . This shows that the difference between pretest and posttest for the intervention group were statistically significant for effort. No statistically significant differences between pretest-posttest for comparison groups (t (7) =.552; p>.05) in effort. From the results obtained, the low achievers of the intervention groups were made more effort in leaning geometry as compared to the comparison group. The effect size d=1.09 indicates a strong effect of the GSP instruction on the intervention group.

The overall motivation of self efficacy and effort from pretest to post test for the intervention group was statistically significant (t (9) =-3.6905, p<.050 and no statistically difference between pretest and post test for the comparison group in the overall motivation (t (7) =-1.115.p>.05).Effect size was computed using Cohen's d to measure the magnitude of the intervention effect. The Cohen's value, d=1.46 indicated that teaching with GSP has a strong effect on the low achievers of intervention group.

This result is consistent with the conclusion of Melczaek(1996) in Dimakos(2010). He concluded that the uses of GSP and students readiness for self direct learning are positively correlated. Nicaise & Barnes (1996) as cited in Dimakos(2010) also suggested that technology enhances students higher levels of thinking as they spend more time in reflecting and analyzing. Detuk(1993),Jackiw(1995) and Ruthven(2008) as cited in

Wilson(2011),concluded that GSP motivates students to think mathematically and enhance engagement. Lee (2000) in Gabriel (2008) also concluded that technology is essential to learning and performance since students take an active role in learning by self directing.

For medium achievers the difference between pretest and posttest in motivation (self efficacy & effort) for IG and CG was evaluated using paired samples t-test. This helped to know whether IG had shown improvement as a result of instruction with GSP and the CG as a result of the traditional paper-pencil instruction. How much was the magnitude of the effect was calculated using Cohen's effect size. The results of the statistical tests were presented in table 4.3.

**Table 4.3.** Self efficacy and effort pretest-posttest comparison for the experimental and comparison MA

| | | | *Pretest* | | *Posttest* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Variables* | *Groups* | *n* | *M* | *SD* | *M* | *SD* | *t* | *P* | *ES* |
| Self Efficacy | IG | 50 | 2.75 | .32 | 2.90 | .38 | -4.062 | .00 | .39 |
| | CG | 49 | 2.7 | .35 | 2.72 | .37 | -.274 | .808 | |
| Effort | IG | 50 | 3.06 | .71 | 3.96 | 1.04 | -9.852 | .00 | 1.01 |
| | CG | 49 | 3.18 | .72 | 3.19 | .69 | -.299 | .766 | |
| Total | IG | 50 | 2.905 | .52 | 3.43 | .71 | -6.957 | .00 | .84 |
| | CG | 49 | 2.94 | .54 | 2.965 | .54 | -1.4015 | .787 | |

From table 4.3. M=2.75, SD=.32 in the pretest and M=2.90, SD=.38 in the posttest. Moreover ;( t (49) =-4.062; $p<.05$). This shows that the differences from pretest to posttest for intervention group were statistically significant for self efficacy. This means instruction with GSP has a small effect on the medium achievers of the intervention group But, no statistically significant differences between pretest-posttest for comparison groups for self efficacy since t (48) = 3.247; $p>.05$.This means the traditional paper-pencil instruction did not bring a significant impact in improving students self efficacy in

on medium groups. The effect size d=.39 is a small effect which shows small improvement in self efficacy on the medium achievers of the intervention group.

Similarly, the paired samples statistical analysis results indicated that the means and standard deviation were M=3.06, SD=.71 in the pretest and M=3.96, SD=1.04 in the posttest and t (49) =-9.852, p<.05.This shows that the difference between pretest and posttest for the Intervention group were statistically significant for effort. No statistically significant differences between pretest-posttest for comparison groups (t (48) =-2.529; p>.05) in effort. The effect size d=1.01 shows a strong effect on the medium achievers of the intervention group.

The overall motivation of self efficacy and effort from pretest to post test for the experimental group was statistically significant (t (49) =-6.957, p<.05 and no statistically difference between pretest and post test for the comparison group in the overall motivation (t (48) =-1.4015, p>.05).Effect size was computed using Cohen's d to measure the magnitude of the intervention effect. Cohen's value (d=.84) was very large according to the Cohen's d. This indicates that effect of instruction using GSP has a less effect on medium achievers as compared to the low achievers.

Melczaek(1996) , cited in Dimakos(2010) supports this idea in that the use of GSP and students readiness for self direct learning are positively correlated. Nicaise & Barnes (1996) as cited in Dimakos(2010) also suggested that technology enhances students higher levels of thinking as they spend more time in reflecting and analyzing. Detuk(1993),Jackiw(1995) and Ruthven(2008) as cited in Wilson(2011),concluded that GSP motivates students to think mathematically and enhance engagement. Lee (2000) in

Gariel(2008) also concluded that technology is essential to learning and performance since students take an active role in learning by self directing.

Similar analogy was used for the higher achievers to see the mean difference between posttest and pretest within each group. The higher achievers had 8 EG and 8 CG. The magnitude of the effect of the treatment was interpreted based on the criteria set by Cohen for effect size (d).Results of statistical test were presented in table 4.4.

**Table 4.4**. Self efficacy and effort pretest-posttest comparison for the Intervention and comparison HA

| | | | *Pretest* | | *Posttest* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Variables* | *Groups* | *n* | *M* | *SD* | *M* | *SD* | *t* | *P* | *ES* |
| Self Efficacy | IG | 8 | 4.24 | .18 | 4.27 | .20 | -.600 | .567 | .1 |
| | CG | 8 | 4.17 | .31 | 4.22 | .29 | -.691 | .512 | |
| Effort | IG | 8 | 4.98 | .94 | 5.28 | .64 | -4.596 | .345 | .38 |
| | CG | 8 | 4.28 | .64 | 5.36 | .66 | -.919 | .388 | |
| Total | IG | 8 | 4.61 | .56 | 4.78 | .42 | -2.598 | .2845 | .34 |
| | CG | 8 | 4.23 | .475 | 4.79 | .475 | -.7155 | .45 | |

In table 4.4. results indicated that M=4.24, SD=.18 in the pretest and M=4.27, SD=.20 in the posttest. Moreover; t (7) =-.600; p >05 for IG and t (7) -.532; p>.05 for CG. This shows that the differences from pretest to posttest for both IG and CG were not statistically significant for self efficacy. That is instruction supported with GSP did the same effect as the traditional paper-pencil instruction on the upper groups. The effect size d=.1 shows that instruction with GSP had insignificant effect on self efficacy mean scores of the upper groups of the IG.

Similarly, the paired samples t-test statistical results indicated that M=4.98, SD=.94 in the pretest and M=5.28, SD=.64 in the posttest and t (9) =-4.596, p>.05 for IG and t (7) =.-.919; p>.05 for CG .This shows that the difference between pretest and posttest for the

intervention and comparison groups were not statistically significant for effort. The effect size d=.38 shows that the effect size is small.

The overall motivation of self efficacy and effort from pretest to post test for the IG was not statistically significant (t (7) =-2.598, p<.05 and no statistically difference between pretest and post test for the CG in the overall motivation (t (7) =-.7155.p>.05). The effect size d=.34 was a small effect according to the Cohen's d. Moreover, this indicates that the treatment had a small effect on high achievers as compared to medium and low achievers.

In order to compare the mean differences between the IG and CG due to the different method of teaching, the independent samples t-test was used. The LA consisted of 10 IG and 8 CG. The self efficacy as well as effort of IG and CG were compared and the magnitude of the effect sizes were also calculated. The results were presented in table 4.5.

**Table 4.5.**Comparison between the Intervention and comparison groups for self efficacy and effort pretest-posttest for LA

| *Variables* | *Measure* | *Groups* | *n* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Self Efficacy | Pretest | IG | 10 | 2.16 | .15 | 16 | 1.502 | .153 | |
| | | CG | 8 | 2.07 | .094 | | | | |
| | Posttest | IG | 10 | 2.77 | .66 | 16 | 2.778 | .013 | 2.35 |
| | | CG | 8 | 2.12 | .11 | | | | |
| Effort | Pretest | IG | 10 | 3.06 | .53 | 16 | -.152 | .881 | |
| | | CG | 8 | 3.094 | .27 | | | | |
| | Posttest | IG | 10 | 3.63 | .63 | 16 | 2.297 | .035 | 1.1 |
| | | CG | 8 | 3.08 | .26 | | | | |
| Total | Pretest | IG | 10 | 2.61 | .34 | 16 | .182 | .517 | |
| | | CG | 8 | 2.582 | .182 | | | | |
| | Posttest | IG | 10 | 3.2 | .645 | 16 | 2.5375 | .024 | 1.2 |
| | | CG | 8 | 2.6 | .184 | | | | |

The pretest results for were M=2.16, SD=.15 for Intervention group and M=2.07, SD=.094 for comparison group in self efficacy. There is no significant difference

between the groups in the pretest for self efficacy (t (16) =1.502, p>.05). The post test results showed that M=2.77, SD=.66 for intervention group and M=2.12, SD=.108 for the comparison group. Moreover; t (16) =2.778, p<.05 for intervention group for self efficacy. This shows that there was a significant difference between the intervention and comparison groups in students self efficacy after the intervention. The magnitude of the effect was 2.35 which shows instruction supported with GSP had highly increased the mean scores of self efficacy in the lower groups.

The table also shows means and standard deviations were, M=3.06, SD=.53 for intervention group and M=3.094, SD=.27 for comparison group in the pretest effort. There was no significant difference between the groups in the pretest for effort (t (16) =-.152, p>.05). The post test results showed that M=3.63, SD=.63 for intervention group and M=3.08, SD=.26 for comparison group for effort. Moreover; t (16) =2.297, p<.05 for intervention group. This shows that there was statistically significant difference between the intervention and comparison groups in effort after the intervention due to GSP instruction intervention. The effect size d=1.1 is a strong effect of the treatment which indicated IG made more effort as compared to the CG.

From the overall motivation of self efficacy and effort conclusion was made that there was statistically significant difference between the intervention groups and comparison groups in post treatment, but no statistically significant difference between the two groups in the pre treatment. Melczaek(1996) , cited in Dimakos(2010) supports this idea in that the use of GSP and students readiness for self direct learning are positively correlated. Nicaise & Barnes (1996) as cited in Dimakos(2010) also suggested that technology enhances students higher levels of thinking as they spend more time in

reflecting and analyzing. Detuk(1993),Jackiw(1995) and Ruthven(2008) as cited in Wilson(2011),concluded that GSP motivates students to think mathematically and enhance engagement. Lee (2000) in Gariel(2008) also concluded that technology is essential to learning and performance since students take an active role in learning by self directing.

The medium achievers of IG had 50 participants and the CG had 49 participants. Their mean differences in self efficacy as well as effort were evaluated using independent samples t-test. The effect sizes were calculated to know the magnitude of effect of treatment as a result of the differences in the teaching methodology in the two groups and results were presented in table 4.6.

**Table 4.6.** Comparison between the Intervention and comparison groups for self efficacy and effort pretest-posttest for MA

| *Variables* | *Measure* | *Groups* | *n* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Self efficacy | Pretest | IG | 50 | 2.75 | .32 | 97 | .734 | .465 | |
| | | CG | 49 | 2.7 | .35 | | | | |
| | Posttest | IG | 50 | 2.90 | .38 | 97 | 2.425 | .017 | .51 |
| | | CG | 49 | 2.71 | .37 | | | | |
| Effort | Pretest | IG | 50 | 3.06 | .71 | 97 | -.825 | .412 | |
| | | CG | 49 | 3.18 | .72 | | | | |
| | Posttest | IG | 50 | 3.96 | 1.04 | 97 | 4.188 | .00 | .84 |
| | | CG | 49 | 3.21 | .707 | | | | |
| Total | Pretest | IG | 50 | 2.91 | .52 | 97 | -.0455 | .4385 | |
| | | CG | 49 | 2.94 | .54 | | | | |
| | Posttest | IG | 50 | 3.43 | .71 | 97 | 3.3064 | .0085 | .74 |
| | | CG | 49 | 2.96 | .54 | | | | |

The pretest results for were M=2.75, SD=.32 for experimental group and M=2.7, SD=.35 for comparison group in self efficacy. There is no significant difference between the groups in the pretest for self efficacy t (97) =.734, p>.05). The post test results showed that M=2.9, SD=.38 for intervention group and M=2.9, SD=.37 for comparison group.

Moreover; t (97) =2.425, p<.05 for self efficacy. This shows that there was a significant difference between the intervention and comparison groups in students self efficacy after the intervention.

Similarly, M=3.06, SD=.71 for Intervention group and M=3.18, SD=.72 for comparison group in the pretest effort. There was no significant difference between the groups in the pretest for effort (t (97) =-.825, p>.05). The post test results showed that M=3.96, SD=1.04 for intervention group and M=3.21, SD=.707 for comparison group for effort. Moreover; t (97) =4.188, p<.05.This shows that there was statistically significant difference between the intervention and comparison groups in effort after the intervention due to GSP instruction intervention.

From the overall motivation of self efficacy and effort conclusion was made that there was statistically significant difference between the intervention groups and comparison groups in post treatment, but no statistically significant difference between the two groups in the pre treatment. The effect size .74 shows a strong effect of GSP instruction on the IG.

Melczaek(1996) , cited in Dimakos(2010) supports this idea in that the use of GSP and students readiness for self direct learning are positively correlated. Nicaise & Barnes (1996) as cited in Dimakos(2010) also suggested that technology enhances students higher levels of thinking as they spend more time in reflecting and analyzing. Detuk(1993),Jackiw(1995) and Ruthven(2008) as cited in Wilson(2011),concluded that GSP motivates students to think mathematically and enhance engagement. Lee (2000) in Gariel(2008) also concluded that technology is essential to learning and performance since students take an active role in learning by self directing.

The mean difference between IG and CG of HA in self efficacy and effort was made before and after the intervention in order to see whether there was a significant difference between the two groups as a result of the different method of teaching or not using the independent samples t-test. Moreover the magnitude of the effect of the treatment was computed using Cohen's effect and results were presented in table 4.7.

**Table 4.7.**Comparison between the Intervention and comparison groups for self efficacy and effort pretest-posttest for HA

| *Variables* | *Measure* | *Groups* | *N* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Self Efficacy | Pretest | IG | 8 | 4.24 | .18 | 14 | .530 | .604 | |
| | | CG | 8 | 4.17 | .31 | | | | |
| | Posttest | IG | 8 | 4.27 | .20 | 14 | .386 | .705 | .20 |
| | | CG | 8 | 4.22 | .29 | | | | |
| Effort | Pretest | IG | 8 | 4.98 | .94 | 14 | -.736 | .474 | |
| | | CG | 8 | 5.28 | .64 | | | | |
| | Posttest | IG | 8 | 5.69 | .64 | 14 | 1.00 | .332 | .37 |
| | | CG | 8 | 5.36 | .66 | | | | |
| Total | Pretest | IG | 8 | 4.61 | .56 | 14 | -.103 | .539 | |
| | | CG | 8 | 4.73 | .48 | | | | |
| | Posttest | IG | 8 | 4.98 | .42 | 14 | .3475 | .5185 | .42 |
| | | CG | 8 | 4.79 | .475 | | | | |

The pretest results were M=4.24, SD=.18 for intervention group and M=4.17, SD=.31 for comparison group in self efficacy. There was no significant difference between the groups in the pretest for self efficacy t (14) =.530, p>.05). The post test results showed that M=4.27, SD=.20 for intervention group and M=4.22, SD=.29 for comparison group. Moreover; t (14) =.386, p>.05 for self efficacy. This shows that there was no a significant difference between the intervention and comparison groups in students self efficacy after the intervention. Similarly, M=4.98, SD=.94 for intervention group and M=5.28, SD=.64 for comparison group in the pretest effort. There was no significant difference between the groups in the pretest for effort (t (14) =-.736, p>.05).

The post test results showed that M=5.69, SD=.64 for Intervention group and M=5.36, SD=.66 for comparison group for effort. Moreover; t (14) =1.004, p>.05.This shows that there was no statistically significant difference between the intervention and comparison groups in effort after the intervention due to GSP instruction intervention.

From the overall motivation of self efficacy and effort conclusion was made that there was no statistically significant difference between the intervention groups and comparison groups in the pre treatment and post treatment. The effect size .42 shows a medium effect for motivating high achievers.

It was also vital to compare the effect of the treatment with respect to sex differences .The lower achievers of IG contained 4 males and 6 females .In order to compare the self efficacy of males and females IG as a result of the intervention of teaching with the GSP their sores were computed using independent samples t-test. Similarly the mean scores of their effort were also computed using the same statistical test. The effect size of the treatment in improving the self efficacy and effort of males and females was analyzed by the Cohen's effect and results were presented in table 4.8.

**Table 4.8.**The comparison of the mean score of posttest results of LA males and females IG

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* | *ES* |
|---|---|---|---|---|---|---|---|
| **Self Efficacy** | | | | | | | |
| Males | 4 | 3.34 | .5 | 3.151 | 8 | .014 | 2.03 |
| Females | 6 | 2.39 | .45 | | | | |
| **Effort** | | | | | | | |
| Males | 4 | 4.2 | .296 | 3.416 | 8 | .009 | 2.2 |
| Females | 6 | 3.25 | .49 | | | | |

Table 4.8 shows that M=3.34, SD=.5 for males and M=2.39, SD=.45 for females in relation to self efficacy. Moreover, t (8) =3.151, P<.05 shows that the differences in the scores of self efficacy between males and females were significantly different. That is

male students were more self efficacious than female students. The effect size d=2.03 indicates that the effect is strong effect. This means that teaching with GSP enhances male students self efficacy as compared to female students.

Similarly M=4.2, SD=.3 for males and M=4.2, SD=.5 for females in relation to effort. Moreover, t (8) =3.416, p<.05 shows that the differences in the scores of effort between males and females were statistically significant. This shows that males made more effort than females to learn geometry. The effect size d=2.2 shows that the effect is strong.

**Table.4.9.**The comparison of the mean score of posttest results of MA males and females' experimental group

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* | *ES* |
|---|---|---|---|---|---|---|---|
| **Self Efficacy** | | | | | | | |
| Males | 28 | 3.03 | .394 | 3.349 | 48 | .002 | .94 |
| Females | 22 | 2.7 | .28 | | | | |
| **Effort** | | | | | | | |
| Males | 28 | 4.52 | .90 | 5.366 | 48 | .00 | 1.53 |
| Females | 22 | 3.25 | .73 | | | | |

Table 4.9 shows that M=3.03, SD=.4 for males and M=2.7, SD=.28 for females in relation to self efficacy. Moreover, t (48) =3.349, P<.05 shows that the differences in the scores of self efficacy between males and females were significantly different. That is male students were more self efficacious than female students. The effect size d=.94 indicates that the effect is strong effect. Similarly M=4.52, SD=.9 for males and M=3.25, SD=.73 for females in relation to effort. Moreover, t (48) =5.366, p<.05 shows that the differences in the scores of effort between males and females were statistically significant. This shows that males made more effort than females to learn geometry. The effect size d=2.2 shows that the effect is strong.

**Table.4.10.**The comparison of the mean score of posttest results of HA males and females intervention group

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|
| **Self Efficacy** | | | | | | |
| Males | 6 | 4.32 | .19 | 1.346 | 6 | .227 |
| Females | 2 | 4.11 | .16 | | | |
| **Effort** | | | | | | |
| Males | 6 | 5.75 | .72 | .276 | 6 | .792 |
| Females | 2 | 5.6 | .28 | | | |

Table 4.10 shows that M=4.32, SD=.19 for males and M=4.11, SD=.16 for females in relation to self efficacy. Moreover, t (6) =1.346, P>05 shows that the differences in the scores of self efficacy between males and females were not significantly different. That is male students were more self efficacious than female students. Similarly M=5.75, SD=.72 for males and M=5.6, SD=.28 for females in relation to effort. Moreover, t (6) =.276, p>05 shows that the differences in the scores of effort between males and females were not statistically significant. This shows that males made more effort than females to learn geometry. The improvement in PSA for each achiever level from pretest to posttest was compared using the paired samples t-test .In table 4.11 below the improvement from pretest to posttest in PSA of lower groups were compared at each stages of Polya model.

Table.4.11. PSA pretest-posttest comparison between experimental and comparison groups for LA

| | | | *Pretest* | | *Posttest* | | *t* | | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| *Subscales* | *Groups* | n | M | SD | M | SD | | P | |
| Understanding | IG | 10 | .79 | .22 | 1.22 | .398 | -3.254 | .01 | .56 |
| | CG | 8 | .77 | .21 | .81 | .25 | -1.423 | .136 | |
| Devising a plan | IG | 10 | .85 | .077 | 1.22 | .266 | -4.145 | .003 | .71 |
| | CG | 8 | .82 | .57 | .78 | .10 | 1.426 | .205 | |
| Carrying out plan | IG | 5 | .71 | .22 | 1.04 | .15 | -5.412 | .006 | 1.7 |
| | CG | 4 | .61 | .14 | .69 | .17 | -3.000 | .058 | |
| Looking back | IG | 4 | .25 | .32 | .89 | .16 | -5.569 | .011 | 1.8 |
| | CG | 4 | .33 | .24 | .50 | .06 | -1.441 | .245 | |

In the above table 4.11., the paired samples t-test results indicated that M=.79, SD=.22 in the pretest and M=1.14, SD=.42 in the posttest for understanding. Moreover; t (9) =-2.620; p<.05.This shows that the differences from pretest to posttest for intervention group in understanding was statistically significant and no significant difference between pretest and posttest for comparison group (t (7) =-1.423, p>.05). This means instruction supported with GSP enhances students problem understanding in problem solving as compared to the traditional method. The effect size d=.56 shows a moderate effect.

The means and standard deviations in devising a plan were M=.85, SD=.077 in the pretest and M=1.00, SD=.28 in the posttest in. Moreover; t (9) =-1.901; p<.05. This shows that the differences from pretest to posttest for IG in devising a plan was statistically significant and no significant difference between pretest and posttest for comparison group (t (7) =-1.426, p>.05). The effect size d=.71 shows a moderate effect.

In carrying out a plan phase the paired samples t-test shows, M=.71, SD=.22 in the pretest and M=1.04, SD=.15 in the posttest. Moreover; t (4) =-5.412; p<.05. This shows that the differences from pretest to posttest for IG in carrying out a plan was statistically significant and no significant difference between pretest and posttest for comparison group (t (3) =-3.00, p>.05). The effect size d=1.7 shows a strong effect.

In the last stage, M=.25, SD=.32 in the pretest and M=.89, SD=.16 in the posttest for looking back. Moreover; t (3) =-5.569; p<.05. This shows that the differences from pretest to posttest for IG in looking back was statistically significant and no significant difference between pretest and posttest for comparison group (t (3) =-1.441, p>.05). The effect size d=1.8 shows a strong effect. This means instruction supported with GSP had great positve impact the mean scores of students' problem solving in looking back phase.

Idris(207) concluded that not few students fail to develop to understand, reasoning and problem solving skills in geometry concepts when learning with traditional approaches. This means the traditional approaches did not support students problem solving ability. Sarracco(2005) also concluded that geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures. Sule(1997) found that teaching –learning conducted by traditional method does not provide students opportunities to actively engage in the problem on their own effort. Pandisscio(2002)also suggested that GSP can benefit students by enabling them to fully understand the ideas embedded in the theorems. Ng &Teong(2003) concluded that GSP provides the possibility of new kinds of tasks and new ways of looking at old tasks. Peterson,Bury and Middlestead(2007) suggested that class room instruction should be supported with appropriate use of technology.

Wertheimer (1990) as cited in Dimakos(2010) found that technology helps students to be mathematical problem solvers since it gives chances to solve problems. Phonguttha, Tayraukham & Nuangehelern (2009), also concluded that technology helps students to draw difficult understandings an creates active problem solving environment.Branfordet.al (1999), as cited in Phonguttha, Tayraukham & Nuangehelern (2009) also found that technology makes educational contexts easier.

The comparison in PSA of the MA was also computed using the paired samples t-test to see their improvement from pretest to posttest and results were presented in table 4.12 below.

**Table 4.12.** PSA pretest-posttest comparison for the experimental and comparison for MA

| | | | *Pretest* | | *Posttest* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Subscales* | *Groups* | *n* | *M* | *SD* | *M* | *SD* | *t* | *P* | *ES* |
| Understanding | IG | 50 | 1.32 | .49 | 1.68 | .46 | -6.491 | .00 | .75 |
| | CG | 49 | 1.42 | .45 | 1.36 | .46 | 1.071 | .289 | |
| Devising a plan | IG | 50 | 1.55 | .66 | 1.86 | .43 | -5.726 | .00 | .556 |
| | CG | 49 | 1.5 | .61 | 1.58 | .55 | -1.639 | .108 | |
| Carrying out plan | IG | 24 | 1.26 | .57 | 1.67 | .51 | -4.068 | .000 | .76 |
| | CG | 30 | 1.13 | .40 | 1.2 | .41 | 1.512 | .141 | |
| Looking back | IG | 23 | .92 | .75 | 1.29 | .64 | -2.371 | .027 | .53 |
| | CG | 24 | 1.06 | .53 | .898 | .66 | .991 | .332 | |

In the above table, results indicated that M=1.32, SD=.49 in the pretest and M=1.68, SD=.46 in the posttest for understanding. Moreover; t (49) =-6.491; p<.05.This shows that the differences from pretest to posttest for intervention group in understanding was statistically significant and no significant difference between pretest and posttest for comparison group (t (48) =-5.726, p>.05).

M=1.55, SD=.66 in the pretest and M=1.86, SD=.43 in the posttest for planning. Moreover; t (49) =-5.726; p<.05.This shows that the differences from pretest to posttest Intervention group in devising a plan was statistically significant and no significant difference between pretest and posttest for comparison group (t (48) =-1.639, p>.05).

M=1.26, SD=.57 in the pretest and M=1.67, SD=.51 in the posttest for carrying out plan phase. Moreover; t (23) =-4.068; p<.05.This shows that the differences from pretest to posttest for intervention group in problem solving was statistically significant and no significant difference between pretest and posttest for comparison group (t (29) =1.512, p>.05).

M=.92, SD=.75 in the pretest and M=1.29, SD=.64 in the posttest for looking back. Moreover; t (22) =-2.371; p<.05.This shows that the differences from pretest to posttest

for Intervention group in looking back was statistically significant and no significant difference between pretest and posttest for comparison group (t (23) =.991, p>.05).

Idris(207) concluded that not few students fail to develop to understand, reasoning and problem solving skills in geometry concepts when learning with traditional approaches. Sarracco(2005) also concluded that geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures. Sule(1997) found that teaching –learning conducted by traditional method does not provide students opportunities to actively engage in the problem on their own effort. Pandisscio(2002)also suggested that GSP can benefit students by enabling them to fully understand the ideas embedded in the theorems. Ng &Teong(2003) concluded that GSP provides the possibility of new kinds of tasks and new ways of looking at old tasks. Peterson,Bury and Middlestead(2007) suggested that class room instruction should be supported with appropriate use of technology.

Wertheimer (1990) as cited in Dimakos(2010) found that technology helps students to be mathematical problem solvers since it gives chances to solve problems. Phonguttha, Tayraukham & Nuangehelern (2009), also concluded that technology helps students to draw difficult understandings an creates active problem solving environment.Branfordet.al (1999), as cited in Phonguttha, Tayraukham & Nuangehelern (2009) also found that technology makes educational contexts easier.

It was also vital to mage comparison of PSA for the upper groups between pretest and posttest in order to see whether there was a significant improvement and results were presented in table 4.13 below.

**Table 4.13**.PSA pretest-posttest comparison for the Intervention and comparison for HA

| *Subscales* | *Groups* | *n* | *Pretest* *M* | *SD* | *Posttest* *M* | *SD* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Understanding | IG | 8 | 2.19 | .32 | 2.15 | .34 | .570 | .587 | .12 |
| | CG | 8 | 2.03 | .29 | 1.99 | .42 | .580 | .580 | |
| Devising a plan | IG | 8 | 2.19 | .36 | 2.27 | .26 | -1.126 | .297 | .26 |
| | CG | 8 | 2.06 | .33 | 2.11 | .37 | -1.528 | .170 | |
| Carrying out plan | IG | 7 | 1.84 | .83 | 1.92 | .79 | -1.355 | .224 | .1 |
| | CG | 7 | 1.89 | .33 | 1.98 | .42 | -1.870 | .111 | |
| Looking back | IG | 7 | 1.68 | .75 | 1.73 | .74 | -.884 | .411 | .07 |
| | CG | 7 | 1.73 | .29 | 1.76 | .32 | -.795 | .457 | |

In the above table, results indicated that M=2.19, SD=.32 in the pretest and M=2.15, SD=.34 in the posttest for understanding. Moreover; t (7) =.570; p>.05.This shows that the differences from pretest to posttest for intervention group in understanding was not statistically significant.

M=2.19, SD=.36 in the pretest and M=2.27, SD=.26 in the posttest for devising a plan Moreover; t (7) =-1.126; p>.05.This shows that the differences from pretest to posttest for Intervention group in devising a plan phase was not statistically significant. Similarly there was no statistically significant difference between pretest and posttest at the remaining stages.

The mean scores in PSA between IG and CG were made for each achiever level. The independent samples t-test in table 4.14 below presented these results for the lower groups.

**Table 4.14.** Comparison between the Intervention and comparison groups for PSA pretest-posttest for LA

| | *Measure* | *Groups* | *N* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Understanding | Pretest | IG | 10 | .79 | .22 | 16 | .241 | .812 | |
| | | CG | 8 | .77 | .21 | | | | |
| | Posttest | IG | 10 | 1.22 | .398 | 16 | 2.549 | .021 | 1.2 |
| | | CG | 8 | .807 | .25 | | | | |
| Devising a plan | Pretest | IG | 10 | .85 | .077 | 16 | .757 | .460 | |
| | | CG | 8 | .82 | .057 | | | | |
| | Posttest | IG | 10 | 1.22 | .27 | 16 | 4.420 | .00 | 2.1 |
| | | CG | 8 | .78 | .101 | | | | |
| Carrying out plan | Pretest | IG | 6 | .71 | .19 | 8 | .831 | .430 | |
| | | CG | 4 | .61 | .14 | | | | |
| | Posttest | IG | 6 | 1.07 | .15 | 8 | 3.736 | .006 | 2.4 |
| | | CG | 4 | .69 | .17 | | | | |
| Looking back | Pretest | IG | 3 | .52 | .17 | 4 | .633 | .561 | |
| | | CG | 3 | .44 | .11 | | | | |
| | Posttest | IG | 5 | .93 | .17 | 7 | 4.827 | .002 | 3.2 |
| | | CG | 4 | .50 | .06 | | | | |

In order to determine the group mean frequencies of problem solving ability, means and standard deviations were calculated for each sub scales using the independent t test.

The pretest results were M=.79, SD=.22 for intervention group and M=.77, SD=.21 for comparison group in problem understanding phase. There was no significant difference between the groups in the pretest in understanding phase t (16) =.241, p>.05). The post test results showed that M=1.22, SD=.398 for experimental group and M=.807, SD=.25 for comparison group. Moreover; t (16) =2.549, p<.05 for understanding phase. This shows that there was a significant difference between the intervention and comparison groups in students understanding after the intervention. More over the effect size d=1.2 in the post treatment for problem understanding.

The results M=.85, SD=.077 for intervention group and M=.82, SD=.057 for comparison group in devising a plan phase. There was no significant difference between the groups in

the pretest for devising a plan (t (16) =.757, p>.05). The post test results showed that M=1.22, SD=.27 for intervention group and M=.78, SD=.101 for comparison group in devising a plan phase. Moreover; t (16) =4.420, p<.05.This shows that there was statistically significant difference between the intervention and comparison groups in devising a plan phase after the intervention due to GSP instruction intervention.

Idris(207) concluded that not few students fail to develop to understand, reasoning and problem solving skills in geometry concepts when learning with traditional approaches. Sarracco(2005) also concluded that geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures. Sule(1997) found that teaching –learning conducted by traditional method does not provide students opportunities to actively engage in the problem on their own effort. Pandisscio(2002)also suggested that GSP can benefit students by enabling them to fully understand the ideas embedded in the theorems. Ng &Teong(2003) concluded that GSP provides the possibility of new kinds of tasks and new ways of looking at old tasks. Peterson, Bury and Middlestead(2007) suggested that class room instruction should be supported with appropriate use of technology.

Wertheimer (1990) as cited in Dimakos(2010) found that technology helps students to be mathematical problem solvers since it gives chances to solve problems. Phonguttha, Tayraukham & Nuangehelern (2009), also concluded that technology helps students to draw difficult understandings an creates active problem solving environment.Branfordet.al (1999), as cited in Phonguttha, Tayraukham & Nuangehelern (2009) also found that technology makes educational contexts easier.

**Table 4.15.**Comparison between the Intervention and comparison groups for PSA pretest-posttest for MA

| *Subscales* | *Measure* | *Groups* | *N* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Understanding | Pretest | IG | 50 | 1.34 | .48 | 97 | .023 | .981 | |
| | | CG | 49 | 1.337 | .46 | | | | |
| | Posttest | IG | 50 | 1.59 | .50 | 97 | 2.631 | .01 | .53 |
| | | CG | 49 | 1.335 | .45 | | | | |
| Devising a plan | Pretest | IG | 50 | 1.58 | .64 | 97 | .015 | .988 | |
| | | CG | 49 | 1.578 | .62 | | | | |
| | Posttest | IG | 50 | 1.81 | .52 | 97 | 2.188 | .031 | .66 |
| | | CG | 49 | 1.56 | .59 | | | | |
| Carrying out plan | Pretest | IG | 21 | 1.34 | .43 | 48 | 1.604 | .115 | |
| | | CG | 29 | 1.17 | .35 | | | | |
| | Posttest | IG | 33 | 1.6 | .42 | 61 | 3.888 | .000 | .46 |
| | | CG | 30 | 1.2 | .41 | | | | |
| Looking back | Pretest | IG | 17 | 1.32 | .46 | 47 | 1.635 | .109 | |
| | | CG | 32 | 1.11 | .42 | | | | |
| | Posttest | IG | 20 | 1.56 | .46 | 39 | 3.543 | .001 | .51 |
| | | CG | 21 | 1.03 | .48 | | | | |

The pretest results for were M=1.34, SD=.48 for intervention group and M=1.337, SD=.46 for comparison group in problem understanding phase. There is no significant difference between the groups in the pretest for self efficacy t (97) =.023, p>.05). The post test results showed that M=1.59, SD=.50 for intervention group and M=1.335, SD=.45 for comparison group. Moreover; t (97) =2.631, p<.05 for problem understanding phase. This shows that there was a significant difference between the intervention and comparison groups in students understanding problem phase after the intervention.

Similarly, M=1.58, SD=.64 for intervention group and M=1.58, SD=.62 for comparison group in the pretest devising a plan. There was no significant difference between the groups in the pretest for devising a plan (t (97) =.015, p>.05). The post test results showed that M=1.81, SD=.52 for Intervention group and M=1.56, SD=.59 for comparison group for devising plan. Moreover; t(97)=2.188,p<.05.This shows that there

was statistically significant difference between the intervention and comparison groups in devising a plan phase after the intervention due to GSP Instruction intervention.

The pretest results for were M=1.34, SD=.43 for intervention group and M=1.17, SD=.35 for comparison group in carrying out a plan phase. There is no significant difference between the groups in the pretest for in carrying out a plan phase t (48) =1.604, p>.05). The post test results showed that M=1.6, SD=.42for intervention group and M=1.2, SD=.41for comparison group. Moreover; t (61) =3.888, p<.05 for problem carrying out a plan phase. This shows that there was a significant difference between the intervention and comparison groups in students in carrying out a plan phase after the intervention.

The pretest results for were M=1.32, SD=.46 for intervention group and M=1.11, SD=.42 for comparison group in problem in looking back phase. There is no significant difference between the groups in the pretest in looking back phase t (47) =1.635, p>.05). The post test results showed that M=1.56, SD=.46 for Intervention group and M=1.03, SD=.48 for comparison group. Moreover; t (39) =3.543, p<.05 for looking back phase. This shows that there was a significant difference between the Intervention and comparison groups in students in looking back phase after the intervention.

Wertheimer (1990) as cited in Dimakos(2010) found that technology helps students to be mathematical problem solvers since it gives chances to solve problems. Phonguttha, Tayraukham & Nuangehelern (2009), also concluded that technology helps students to draw difficult understandings an creates active problem solving environment.Branfordet.al (1999), as cited in Phonguttha, Tayraukham & Nuangehelern (2009) also found that technology makes educational contexts easier.

Idris(207) concluded that not few students fail to develop to understand, reasoning and problem solving skills in geometry concepts when learning with traditional approaches. Sarracco(2005) also concluded that geometry software can help students in understanding key concepts by enabling them to visualize and investigate various figures. Sule(1997) found that teaching –learning conducted by traditional method does not provide students opportunities to actively engage in the problem on their own effort. Pandisscio(2002)also suggested that GSP can benefit students by enabling them to fully understand the ideas embedded in the theorems. Ng &Teong(2003) concluded that GSP provides the possibility of new kinds of tasks and new ways of looking at old tasks. Peterson,Bury and Middlestead(2007) suggested that class room instruction should be supported with appropriate use of technology.

**Table 4.16.** Comparison between the Intervention and comparison groups for PSA pretest-posttest for HA

| *Subscales* | *Measure* | *Groups* | *N* | *M* | *SD* | *df* | *t* | *P* | *ES* |
|---|---|---|---|---|---|---|---|---|---|
| Understanding | Pretest | IG | 8 | 2.2 | .32 | 14 | 1.092 | .293 | |
| | | CG | 8 | 2.03 | .29 | | | | |
| | Posttest | IG | 8 | 2.15 | .34 | 14 | .870 | .399 | .42 |
| | | CG | 8 | 1.99 | .42 | | | | |
| Devising a plan | Pretest | IG | 8 | 2.19 | .36 | 14 | .803 | .436 | |
| | | CG | 8 | 2.06 | .33 | | | | |
| | Posttest | IG | 8 | 2.28 | .26 | 14 | 1.042 | .315 | .53 |
| | | CG | 8 | 2.11 | .37 | | | | |
| Carrying out a plan | Pretest | IG | 6 | 2.15 | .21 | 11 | -1.671 | .123 | |
| | | CG | 7 | 1.89 | .33 | | | | |
| | Posttest | IG | 7 | 1.92 | .79 | 12 | -.185 | .856 | .33 |
| | | CG | 7 | 1.98 | .42 | | | | |
| Looking back | Pretest | IG | 6 | 1.96 | .13 | 11 | 1.783 | .102 | |
| | | CG | 7 | 1.73 | .29 | | | | |
| | Posttest | IG | 7 | 1.82 | .77 | 12 | -.002 | .998 | .41 |
| | | CG | 7 | 1.83 | .35 | | | | |

The pretest results for were M=2.2, SD=.32 for intervention group and M=2.03, SD=.29 for comparison group in problem understanding phase. There is no significant difference between the groups in the pretest for understanding the problem phase t (14) =1.092, p>.05). The post test results showed that M=2.15, SD=.34 for Intervention group and M=1.99, SD=42 for comparison group. Moreover; t (14) =.803, p<.05 problem understanding. This shows that there was a significant difference between the intervention and comparison groups in students' problem understanding after the intervention.

Similarly, M=2.19, SD=.36 for intervention group and M=2.06, SD=.33 for comparison group in the pretest devising a plan. There was no significant difference between the groups in the pretest for devising a plan (t (14) =.803, p>.05). The post test results showed that M=2.28, SD=.26 for Intervention group and M=2.11, SD=.37 for comparison group for devising plan. Moreover; t(14)=1.042,p<.05.This shows that there was statistically significant difference between the intervention and comparison groups in devising a plan phase after the intervention due to GSP Instruction intervention.

The pretest results for were M=2.15, SD=.21 for intervention group and M=1.89, SD=.33 for comparison group in carrying out a plan phase. There is no significant difference between the groups in the pretest for in carrying out a plan phase t (11) =-1.671, p>.05). The post test results showed that M=1.92, SD=.79 for intervention group and M=1.98, SD=.42 for comparison group. Moreover; t (12) =-.185, p<.05 for problem carrying out a plan phase. This shows that there was a significant difference between the Intervention and comparison groups in students in carrying out a plan phase after the intervention.

The pretest results for were M=1.96, SD=.13 for intervention group and M=1.73, SD=.29for comparison group in problem in looking back phase. There is no significant difference between the groups in the pretest in looking back phase t (11) =1.783, p>.05). The post test results showed that M=1.82, SD=.77 for intervention group and M=1.83, SD=.35for comparison group. Moreover; t (12) =-.002, p<.05 for looking back phase. This shows that there was a significant difference between the intervention and comparison groups in students in looking back phase after the intervention.

**Table.4.17.**The comparison of the mean score of posttest results of LA males and females Intervention group

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|
| Understanding | | | | | | |
| Males | 4 | 1.58 | .25 | 3.502 | 8 | .008 |
| Females | 6 | .98 | .27 | | | |
| Devising a plan | | | | | | |
| Males | 4 | 1.42 | .19 | 2.387 | 8 | .046 |
| Females | 6 | 1.09 | .23 | | | |
| Carrying out plan | | | | | | |
| Males | 4 | 1.25 | .11 | 4.073 | 4 | .015 |
| Females | 2 | .72 | .24 | | | |
| Looking back | | | | | | |
| Males | 3 | 1.2 | .11 | 7.752 | 3 | .004 |
| Females | 2 | .5 | .079 | | | |

Table 4.17 shows that M=1.58, SD=.25 for males and M=.98, SD=.27for females in relation to problem understanding phase. Moreover, t (8) =3.502, P<05 shows that the differences in the scores of problem understanding between males and females were significantly different. That is male students understands the problem than female students do. In devising a plan phase. M=1.42, SD=.19 for males and M=1.09, SD=.23 for females. Moreover, t (8) =2.387, p<05 shows that the differences in the scores of

effort between males and females were statistically significant. This shows that males were better in devising a plan phase than females in learning geometry.

In carrying out a plan, M=1.25, SD=.11 for males and M=.72, SD=.24 for females. Moreover, t (4) =4.073, p<05 shows that the differences in the scores of carrying out a plan between males and females were statistically significant. In the final phase, looking back, M=1.2, SD=.11 for males and M=.5, SD=.079for females. Moreover, t (3) =7.752, p<05 shows that the differences in the scores of looking back between males and females were statistically significant.

**Table.4.18.**The comparison of the mean score of posttest results of MA males and females Intervention group

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|
| Understanding | | | | | | |
| Males | 28 | 1.91 | .37 | 5.027 | 48 | .00 |
| Females | 22 | 1.37 | .39 | | | |
| Devising a plan | | | | | | |
| Males | 28 | 1.98 | .42 | 2.266 | 48 | .028 |
| Females | 22 | 1.71 | .40 | | | |
| Carrying out plan | | | | | | |
| Males | 18 | 1.99 | .35 | 4.975 | 31 | .00 |
| Females | 15 | 1.38 | .52 | | | |
| Looking back | | | | | | |
| Males | 12 | 1.73 | .36 | 3.012 | 28 | .004 |
| Females | 8 | 1.22 | .52 | | | |

Table 4.18 shows that M=1.91, SD=.37 for males and M=1.37, SD=.39 for females in relation to problem understanding phase. Moreover, t (48) =5.027, P<05 shows that the differences in the scores of problem understanding between males and females were significantly different. That is male students understands the problem than female students do. In devising a plan phase. M=1.98, SD=.42 for males and M=1.71, SD=.40 for females. Moreover, t (48) =2.266, p<05 shows that the differences in the scores in

planning phase between males and females were statistically significant. This shows that males were better in devising a plan phase than females in learning geometry.

In carrying out a plan, M=1.99, SD=.35 for males and M=1.38, SD=1.38 for females. Moreover, t (31) =4.975, p<.05 shows that the differences in the scores of carrying out a plan between males and females were statistically significant. In the final phase, looking back, M=1.73, SD=.36 for males and M=1.22, SD=.52 for females. Moreover, t (28) =3.012, p<05 shows that the differences in the scores of looking back between males and females were not statistically significant.

**Table.4.19**.The comparison of the mean score of posttest results of MA males and females Intervention group

| *Variables* | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|
| Understanding | | | | | | |
| Males | 6 | 2.24 | .33 | 1.334 | 6 | .231 |
| Females | 2 | 1.9 | .31 | | | |
| Devising a plan | | | | | | |
| Males | 6 | 2.8 | .29 | -.004 | 6 | .997 |
| Females | 2 | 2.8 | .24 | | | |
| Carrying out plan | | | | | | |
| Males | 6 | 2.2 | .44 | .172 | 5 | .869 |
| Females | 1 | 2.17 | .079 | | | |
| Looking back | | | | | | |
| Males | 6 | 2.18 | .37 | -.935 | 5 | .386 |
| Females | 1 | 2.11 | .003 | | | |

Table 4.19 shows that M=2.24, SD=.33 for males and M=1.9, SD=.31 for females in relation to problem understanding phase. Moreover, t (6) =1.334, P>05 shows that the differences in the scores of problem understanding between males and females were not significantly different. In devising a plan phase. M=2.8, SD=.29 for males and M=2.8, SD=.24 for females. Moreover, t (6) =-.004, p<05 shows that the differences in the scores in planning phase between males and females were not statistically significant. In

carrying out a plan, M=2.2, SD=.44 for males and M=2.17, SD=.79 for females. Moreover, t (5) =.172, p>05 shows that the differences in the scores of carrying out a plan between males and females were not statistically significant. In the final phase, looking back, M=2.18, SD=.37 for males and M=2.11, SD=.003 for females. Moreover, t (5) =-.935, p>05 shows that the differences in the scores of looking back between males and females were not statistically significant.

The differences between the mean scores of self efficacy, effort and problem solving ability with respect to the three achiever levels were computed using ANOVA. The MS between groups is the ratio of SS between groups to the degree of freedom between groups. Similarly the MS within groups is the ratio of SS within groups to degree of freedom within groups. F is the ratio of MS between to MS within. It measures how large is the effect of between groups as compared to the error within groups.

The IG contained 10 lower groups, 50 medium groups and 8 upper groups. It was also vital to compare the mean scores of self efficacy to see whether there was a significant difference between groups and within groups across the achiever levels and results were presented in table 4.20.

**Table.4.20.**ANOVA test of the mean difference of self efficacy the different achiever levels of the Intervention group

| *Variables* | *df* | *SS* | *MS* | *F* | *P* |
|---|---|---|---|---|---|
| Self Efficacy | | | | | |
| Between groups | 2 | 13.830 | 6.915 | 40.130 | .00 |
| Within groups | 65 | 11.20 | .172 | | |
| Total | 67 | 25.030 | | | |

As shown in table 4.20. SS=13.830, MS=6.915 between groups and SS=11.20, MS=.172 within groups for self efficacy. Moreover, F (2, 67) =40.130 p < 0:05, it can be concluded that the differences between students' self efficacy of the groups low, medium and high

were statistically significant. That is instruction supported with GSP helped the IG in enhancing students self efficacy within and between the groups across the achiever levels. In order to know between which achiever level groups was the difference was statistically significant the results in table 4.20 should be followed by Tukey HSD, an extension version of ANOVA, was used and results were presented in table 4.20.a. below.

**Table.4.20.a**.ANOVA test of the mean difference of self efficacy the different achiever levels of the Intervention group

| | | | | | *95% confidence Interval* | |
|---|---|---|---|---|---|---|
| *I* | *J* | *Mean Difference(I-J)* | *Std.Error* | *p* | *Lower bound* | *Upper bound* |
| LA | MA | -.12571 | .14380 | .658 | -.4706 | .2192 |
| | HA | -1.49780* | .19690 | .00 | -1.9701 | -1.0255 |
| MA | LA | .12571 | .14380 | .658 | -.2192 | .4706 |
| | HA | -1.37209* | .15807 | .00 | -1.7512 | -.9930 |
| HA | LA | 1.49780* | .19690 | .00 | 1.0255 | 1.9701 |
| | MA | 1.37209* | .15807 | .00 | .9930 | 1.7512 |

*The mean difference is significant at .05 levels

The ANOVA table doe not tell us between which groups is the difference is significant. To know this Tukey HSD (Honestly Significant Difference) was used. From Tukey HSD self efficacy for the lower achievers made a significant difference with high achievers with mean difference of -1.49780, medium achievers made a significant difference with high achievers with mean difference of -.1.37209 and HA made a significant difference with both LA and MA with mean differences of 1.49780 and 1.37209 taken in order.

Similarly, the mean difference across the achiever levels were compared for effort using ANOVA to see whether instruction supported with GSP brought a significant impact in improving students' effort. The results of ANOVA were presented in table 4.21.below.

**Table 4.21.** ANOVA test of the mean difference effort the different achiever levels of the Intervention group

| *Variables* | *df* | *SS* | *MS* | *F* | *P* |
|---|---|---|---|---|---|
| Between groups | 2 | 23.384 | 11.692 | 12.750 | .00 |
| Within groups | 65 | 59.608 | .917 | | |
| Total | 67 | 82.992 | | | |

Table 4.21 shows that SS=23.384 MS=11.692 between groups and SS=59.608 MS=.915 within groups for effort. Moreover, F =12.750, p < 0:05, it can be concluded that the differences between students' effort of the groups low, medium and high were statistically significant. The next question was which pairs made significant difference in self efficacy. This should answered by Tukey Honestly significant Difference(HSD) which is an extended version of ANOVA and results were presented in table 4.21.a.

**Table 4.21.a.** ANOVA test of the mean difference effort the different achiever levels of the Intervention group

| | | *Mean Difference(I-J)* | | | *95% confidence Interval* | |
|---|---|---|---|---|---|---|
| *I* | *J* | | *Std.Error* | *p* | *Lower bound* | *Upper bound* |
| LA | MA | -.33500 | .33173 | .573 | -1.1307 | .4607 |
| | HA | -2.06250* | .45424 | .00 | -3.1520 | -.9730 |
| MA | LA | .33500 | .33173 | .573 | -.4607 | 1.1307 |
| | HA | -1.72750* | .36465 | .00 | -2.6021 | -.8529 |
| HA | LA | 2.06250* | .45424 | .00 | .9730 | 3.1520 |
| | MA | 1.72750* | .36465 | .00 | .8529 | 2.6021 |

*The mean difference is significant at .05 levels

The ANOVA table doe not tell us between which groups is the difference is significant. To know this we use the Tukey HSD (Honestly Significant Difference).From the Tukey the lower achievers made a significant difference with high achievers (which is -2.06250) and medium achievers made a significant difference with high achievers (which is -1.72750) in effort. From these conclusion can be made that instruction supported with GSP positively affected students effort to tackle geometry concepts which increased their motivation.

**Table 4.22.**ANOVA test of the mean difference of PSA the different achiever levels of the Intervention group

| *Variables* | *df* | *SS* | *MS* | *F* | *P* |
|---|---|---|---|---|---|
| Between groups | 2 | 3.998 | 1.999 | 15.515 | .000 |
| Within groups | 65 | 8.374 | .129 | | |
| Total | 67 | 12.371 | | | |

Table 4.22.shows that SS=3.998, MS=.1.999 between groups and SS=8.374, MS=.129 within groups for PSA. Moreover, F =15.515, p < 0:05, it can be concluded that the differences between students' PSA of the groups low, medium and high were statistically significant.

**Table 4.22.b.**ANOVA test of the mean difference of PSA the different achiever levels of the Intervention group

| *I* | *J* | *Mean Difference(I-J)* | *Std. Error* | *Sig.* | *95% Confidence Interval* | |
|---|---|---|---|---|---|---|
| | | | | | *Upper Bound* | *Lower Bound* |
| LA | MA | -.48505(*) | .12433 | .001 | -.7833 | -.1868 |
| | HA | -.94140(*) | .17025 | .000 | -1.3498 | -.5330 |
| MA | LA | .48505(*) | .12433 | .001 | .1868 | .7833 |
| | HA | -.45635(*) | .13667 | .004 | -.7842 | -.1285 |
| HA | LA | .94140(*) | .17025 | .000 | .5330 | 1.3498 |
| | MA | .45635(*) | .13667 | .004 | .1285 | .7842 |

* The mean difference is significant at the .05 level.

The ANOVA table doe not tell us between which groups is the difference is significant. To know this Tukey HSD (Honestly Significant Difference) was used .From the Tukey the LA made a significant difference with MA and HA in PSA with mean differences of -.48505 and -.94140 taken in this order.MA also made a significant difference with HA with had a mean difference of -.45635.From these we concluded that there was a significant difference between each pair of achiever levels. This teaching with GSP helped IG to create opportunities to solve geometrical problems in their own so as to enhance their PSA across the achiever levels.

From the relationship between motivation and problem solving ability conclusion can be made that they were positively correlated. This idea was also supported with some research findings of the study. Under appropriate conditions motivation may help insight problem solving and contributes to the ability to solve problems (Weith & Burns, 2005). Based on several problem solving models, O'Neil & Schacter (1997) developed the CRESST model of problem solving that incorporates four elements; content understanding, problem solving strategies, metacognition and motivation. In order to the effect of motivation on problem solving regression analysis was required and results are presented in tables 4.23, & 4.24.

**Table.4.23.** Regression Analysis of variables of motivation (self efficacy &Effort) and problem solving ability of the LA of IG

| Multiple R=.989 | | | | $R^2$=.978 | |
|---|---|---|---|---|---|
| ANOVA Table | | | | | |
| | *SS* | *df* | *MS* | *F* | *P* |
| Regression | .682 | 2 | .341 | 153.143 | .000[b] |
| Residual | .016 | 7 | .002 | | |
| Total | .698 | 9 | | | |
| Variables in the Equation | | | | | |
| Model | r | β | Std. Error | Beta | T | p |
| Constant | - | -.100 | .112 | | -.894 | .401 |
| Self Efficacy | .978 | .224 | .078 | .527 | 2.868 | .024 |
| Effort | .975 | .210 | .081 | .474 | 2.579 | .037 |

The Pearson correlation shows that coefficient between problem solving ability and self efficacy was r=.978 and problem solving ability and effort was r=.975 showing that there is a strong positive linear correlation because the value is positive and very close to 1.This means the data points should be clustered closely about a positively sloping regression line.

In the regression table above, the value of F (2, 9) = 153.143 and sig. =.00 indicates that the multiple correlation R were statistically significant. That is the contributions all variables self efficacy and effort were significantly affect problem solving ability. Moreover the constant, self efficacy and effort all are statistically significant. That is they all separately affect problem solving ability of the experimental group. From the regression table above, the coefficient of determination $R^2$ =.978 indicates that self efficacy and effort had total effect of 97.8% on problem solving ability. The regression equation that best approximates the relationship between problem solving ability, self efficacy and effort is expressed as y=.224x1+.21x2-.1, where,$X_1$=self-efficacy,$X_2$=effort, y=Problem solving ability.

The formula that relates coefficient of determination ($R^2$), Self Efficacy (SE) and Effort (E) is,$R^2=\beta_{SE}r_{SE+}\beta ErE$, where,$R^2$ =Coefficient of determination, β =Beta value in coefficients table and r =zero order in parts & partial correlations

$R^2=\beta_{SE}r_{SE+}\beta ErE$=.978*.527+.975*.474=.515406+.46215=.978=51.54%+46.22%=97.76.2 %.Therefore, self efficacy enhances students' problem solving ability by 51.54% and effort contributes about 46.22%. Percentage of variance of the predicted variable ($1-R^{2)}$ due to the factors other than the predicted variables (self efficacy &effort) is 2.

This supported by Song (2005), who concluded that effort is one of the component that enable students to engage in the process of problem solving. Under appropriate conditions motivation contributes to the ability of students to solve problems (Weith & Burns, 2005).In the crest model of O'Neil & Schacter(1997) as cited in Weith & Burns(2005),it was indicated that motivation and problem solving have relationships.

**Table.4.24.**Regression Analysis of variables of motivation (self efficacy &Effort) and problem solving ability of the medium achiever Intervention group

| Multiple R=.804 | | | | | | |
|---|---|---|---|---|---|---|
| ANOVA Table | | | | $R^2$=.646 | | |
| | *SS* | *df* | *MS* | *F* | *P* | |
| Regression | 4.656 | 2 | 2.328 | 42.876 | .000[b] | |
| Residual | 2.552 | 47 | .054 | | | |
| Total | 7.209 | 49 | | | | |
| Variables in the Equation | | | | | | |
| Model | r | β | Std. Error | Beta | T | P |
| Constant | - | .200 | .261 | | .764 | .449 |
| Self Efficacy | .634 | .213 | .116 | .210 | 1.840 | .072 |
| Effort | .788 | .240 | .042 | .651 | 5.685 | .000 |

In the regression table above, the value of F (2, 49) = 42.876 and sig. =.00 indicates that the multiple correlation R were statistically significant. That is the contributions all variables self efficacy and effort were significantly affect problem solving ability. From the regression table above, the coefficient of determination $R^2$ =.646 indicates that self efficacy and effort had total effect of 64.6% on problem solving ability. The regression equation that best approximates the relationship between problem solving ability, self efficacy and effort is expressed as y=.240x1+.213x2+.2

$R^2=\beta_{SE}r_{SE}+\beta_{E}r_{E}$=.634×.210+.788×.651=.13314+.512988=.651.646=13.3%+51.3.4%=64.6 %.Therefore, self efficacy enhances students' problem solving ability by 13.3% and effort contributes about 51.3%. Percentage of variance of the predicted variable ($1-R^{2)}$ due to the factors other than the predicted variables (self efficacy &effort) is 35.4%.

This supported by Song (2005), who concluded that effort is one of the component that enable students to engage in the process of problem solving. Under appropriate conditions motivation contributes to the ability of students to solve problems (Weith & Burns, 2005).In the crest model of O'Neil & Schacter(1997) as cited in Weith & Burns(2005),it was indicated that motivation and problem solving have relationships.

# CHAPTER FIVE: Summary, Conclusions and Recommendations

## 5.1. Summary

This study was conducted to investigate GSP and students, motivation and problem solving ability. The objective was basically to answer two research questions (1) what is the effect of instruction with GSP on student motivation in geometry? and (2) What is the effect of instruction with GSP on students problem solving ability in geometry?.3) What is the effect of motivation on students problem solving ability when the they are taught with GSP?

In order to answer these questions method and design of the study were developed. The experimental research method with pretest-posttest nonequivalent group quasi experimental design was used. Two sections were purposely selected out of 10 sections using purposive sampling and they were considered as intact classes. One of the two sections was randomly selected and assigned as experimental and the other as comparison group.

Self efficacy Measuring Questionnaire (SEMQ), Effort Measuring Questionnaire (EMQ), and Problem Solving Ability Measuring Questions (PSAMQ) were instruments used to collect data. These instruments were pilot tested to check their validity and reliability. Instruments were administered to both groups as a pretest to see how similar or different the groups were in self efficacy, effort and problem solving ability. Data collected from pretest were analyzed using statistical test. There was no significant difference between the two groups in self efficacy, effort and problem solving ability prior to intervention. Treatment was applied to the IG for four weeks while at the same time the CG received instruction with traditional paper –pencil instruction. At the end of the treatment SEMQ,

EMQ and PSAMQ were applied to both groups and data collected using instruments were analyzed using statistical tests. The statistical test results shows that the mean difference between the IG and CG in self efficacy, effort and PSA were statistically significant. This means IG taught with GSP were better motivated to learn geometry and became better geometrical problem solvers as compared to the comparison group.

**5.2. Conclusion**

Based on the statistical analysis and findings of the study, the following conclusions were made. Students who received instruction with GSP were more self efficacious and engaged in a given geometry tasks .That is students who received instruction with GSP were better motivated than students who received traditional paper-pencil instruction .Melczaek(1996) , cited in Dimakos(2010) supports this idea in that the use of GSP and students readiness for self direct learning are positively correlated. Nicaise & Barnes (1996) as cited in Dimakos(2010) also suggested that technology enhances students higher levels of thinking as they spend more time in reflecting and analyzing. Detuk(1993),Jackiw(1995) and Ruthven(2008) as cited in Wilson(2011),concluded that GSP motivates students to think mathematically and enhance engagement. Lee (2000) in Gariel(2008) also concluded that technology is essential to learning and performance since students take an active role in learning by self directing.

Similarly, students who received instruction with GSP were better problem solvers at all Polya's stages. Wertheimer (1990) as cited in Dimakos(2010) found that technology helps students to be mathematical problem solvers since it gives chances to solve problems. Phonguttha, Tayraukham & Nuangehelern (2009), also concluded that technology helps students to draw difficult understandings an creates active problem

solving environment.Branfordet.al (1999), as cited in Phonguttha, Tayraukham & Nuangehelern (2009) also found that technology makes educational contexts easier.

From the regression analysis motivation has a significant effect on problem solving ability especially on low and medium achievers. This supported by Song (2005), who concluded that effort is one of the component that enable students to engage in the process of problem solving. Under appropriate conditions motivation contributes to the ability of students to solve problems (Weith & Burns, 2005).In the crest model of O'Neil & Schacter(1997) as cited in Weith & Burns(2005),it was indicated that motivation and problem solving have relationships. In general, from the results in this study, instruction with GSP is very useful to enhance students' motivation and problem solving ability.

**5.3. Recommendations**

The objective of the study was to determine the relationship between GSP, motivation and problem solving ability. To this end the research questions were positively answered. It is the researcher's pleasure if one goes through this study and grasps some concepts on about the characteristics exhibited by this dynamic geometry software, GSP, its relations with motivation and problem solving ability. The researcher attempted all his bests to figure out the relationship between GSP, motivation and problem solving ability. I hope this study may serve as a footing step to widen it better than this. In order to fill the gaps what were untouched in this study and findings obtained the following recommendations were made.

1.This study was made at secondary school. This means that there is a need for further studies in primary schools, preparatory levels, college and University levels.

2.Training and seminars should be given for mathematics teachers to give awareness on the GSP technology.

3.The government and mathematicians should give attention to the GSP technology so that it becomes popular and part of mathematics curriculum in Ethiopia.

4.Duration of the treatment was 4 weeks .The researcher recommends that long term studies should be taken to know further about the effect of technology on motivation and problem solving ability.

5.The researcher considered only two elements of motivation, Self efficacy and effort that are more related to the topic under study. The researcher recommends that, researches should be done on the other elements of motivation.

6.From the results obtained in this study and previous studies, we concluded that GSP has a significant effect on students' motivation and problem solving ability in geometry. Therefore, the researcher recommends that more emphasis should be given on the use of computer and GSP programs in mathematics and in education.

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# Appendices

## Appendix A: Self Efficacy Measuring Questionnaire (SEMQ) and Effort Measuring Questionnaire (EMQ)

ADDIS ABABA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL STUDIES

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

Questionnaire to be answered by grade 9 students

General Direction

This questionnaire is prepared to collect data that will be used for my Master Thesis as Partial fulfillment of the program of graduate studies at Addis Ababa University. The study is aimed collecting data on student's **self efficacy** and **Effort** in geometry learning motivation. **Self-efficacy** refers to the confidence students have in their abilities for success in a given task. **Effort** is amount of time that students expend in solving mathematical problems established by their teacher .Both are critical variables identified to measure students motivation with respect to problem solving ability for this particular study. Your responses are the only way to reach at reliable research results your responses will be kept confidential. Thus you are kindly requested to complete the questionnaire carefully and honestly.

Do not write your name

1. General Information

Name of your School_____

Woreda_____

2. Personal Information2.1 Sex Male ☐ Female ☐

PART –A

Complete this part of the questionnaire based on the following rating scales.

5- Strongly Agree (SA) 4-Agree (A) 3-Undecided (U) 2-Disagree (D)

1-Strongly Disagree (SD)

To what extent do you agree with the following Statements?

Please complete this Part of the questionnaire by putting "x"in one the boxes as appropriate

| SN | Statements | Rating Scales | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | I feel confident enough to ask questions in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeters of triangles and parallelograms in a class. | | | | | |
| 2 | I do not believe I can do well on a test in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 3 | I believe I can complete all of the assignments in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 4 | I don't believe I am the kind of student who is good at doing a task on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms . | | | | | |
| 5 | I believe I will be able to use geometry in my future career when needed. | | | | | |
| 6 | I believe I can't understand the content in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 7 | I believe I can get a good mark when I take tests on the concept of similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms . | | | | | |
| 8 | I don't believe I can learn well lessons in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 9 | I feel confident when taking a geometry test in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 10 | I believe I am not the type of student who can do activities in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | I feel that I will be able to do well in future geometry lessons in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 12 | I believe I can't do the mathematics in similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | |
| 13 | I believe I can think like a mathematician. | | | | | |
| 14 | I do not feel confident when using geometry on the concepts of similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms outside of school. | | | | | |

PART-B

Complete this part of the questionnaire based on the following rating scales.

1-Not at all true 2- Not true 3- Somewhat not true
4-Undecided
5-Somewhat true 6-True 7-Very true

To what extent do you agree with the following Statements? Please complete this Part of the questionnaire by putting "x"in one the boxes as appropriate

| SN | Statements | Rating scales | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | I do not work hard to do well on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms, even if I do not like what I am are doing. | | | | | | | |
| 2 | I work very hard to prepare for skills tests on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | | | |
| 3 | I always I always do not pay attention to my teacher when I learn on concepts of similarities of triangles, areas and perimeters of s sectors and segments, areas and Perimeter of triangles and parallelograms. | | | | | | | |
| 4 | I try to learn and to do well on activities of similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms, even if the activity is boring. | | | | | | | |
| 5 | When something that I am practicing on similarities | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms is difficult, I do not spend extra time and effort trying to do it right. | | | | | | | |
| 6 | I put a lot of effort into preparing for skill tests on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms. | | | | | | | |
| 7 | When I have trouble performing some skills on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms, I do not go back and practice. | | | | | | | |
| 8 | Regardless of whether or not I like the activities on similarities of triangles, areas and perimeters of sectors and segments, areas and perimeter of triangles and parallelograms, I work my hardest to do them. | | | | | | | |

Thank you for completing the questionnaire

Appendix B: Problem solving ability Measuring Questions (PSAMQ)

Name_____ Grade_____
Section_____ Roll No_____
Dear students,
You are given a problem on area of triangles and parallelograms consisting of 9 questions. These problems are prepared to determine your problem solving ability in Similarities of triangles, area of sectors, area of segments, areas of triangles and parallelograms. For the validity of this research, while solving show all the necessary steps.
You have an hour to work on the problems.
Thank you, Good luck

1. In Δ ABC, $\overline{BE}$ and $\overline{CF}$ are altitude of the triangle. If AB= 6 cm, AC=5 cm and CF =4 units, Find the length of BE.
2. In Δ DEF, if DE=7cm, EF=9cm and DF=12cm, find the area of Δ DEF.
3. Find the area of a rhombus whose diagonals are 5 inches & 6 inches long
4. In the parallelogram ABCD, AB=2cm, AD=3cm and m (<B) $=60^0$
Find the length of the altitude from B to $AD$ .
5. PQRS is a parallelogram of area18 $cm^2$.If PQ=5cm and QR=4cm Calculate the lengths of the corresponding heights
6. Let ABCD and EFGH be two similar quadrilaterals such that ABCD ~ EFGH. If AB=15cm, EF=18=18cm and the perimeter of ABCD is 40cm, find the perimeter of EFGH.
7. Two triangles are similar .A side of one triangle is 2cm .The corresponding side of the other is 5 cm. what is the ratio of their areas and perimeters.
8. The sides of a polygon have lengths 5, 7, 8, 11 and 19 units. The perimeter of a similar polygon is 75cm.Find the lengths of the sides of the larger polygon.
9. Square ABCD is inscribed in a circle of radius 4cm.Find the area of the minor segment cut off by the cord AB.
10. In Δ ABC. If AB=15cm, BC=14 and AC=13cm.Find the area of ΔABC and the measure of <B.
11. A chord of a circle of radius 5cm is 8cm long. Find the distance of the chord from the center.
12. Find the perimeter and area of a segment of a circle of radius 8cm cut off by a chord that subtends a central angle of $\pi/3$ radians.

.

## Appendix C: Pilot Test Results

Items developed to collect data on" **GSP and Geometry learning Motivation and Problem Solving ability**" were pilot tested at Derba Secondary School. The results obtained on each item were analyzed below.

**A) Content Validity**

Mathematics Teachers Responses on Self efficacy Items for content validity

| Respondents | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 3 | 1 | 3 | 4 | 3 | 3 | 4 | 3 | 2 | 2 | 3 |
| 2 | 3 | 1 | 3 | 4 | 4 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 1 |
| 3 | 2 | 4 | 4 | 3 | 3 | 3 | 1 | 4 | 3 | 3 | 2 | 3 | 3 | 4 |
| 4 | 4 | 3 | 3 | 2 | 4 | 4 | 3 | 3 | 4 | 1 | 3 | 3 | 4 | 4 |
| **CVI** | **.75** | **.75** | **1.0** | **.75** | **.75** | **.75** | **.75** | **1.0** | **.75** | **.75** | **.75** | **.75** | **.75** | **.75** |

$$\text{CVI (SEMQ)} = \frac{.75+.75.1.0+.75+.75+.75+.75+1}{14} = \frac{.0+.75+.75+.75+.75+.75+.75}{14} = .79$$

| Item Code | CVI | Remarks |
|---|---|---|
| **1** | .75 | Item accepted |
| **2** | .75 | Item accepted |
| **3** | 1.0 | Item accepted |
| **4** | .75 | Item accepted |
| **5** | .75 | Item accepted |
| **6** | .75 | Item accepted |
| **7** | .75 | Item accepted |
| **8** | 1.0 | Item accepted |
| **9** | .75 | Item accepted |
| **10** | .75 | Item accepted |
| **11** | .75 | Item accepted |
| **12** | .75 | Item accepted |
| **13** | .75 | Item accepted |
| **14** | .75 | Item accepted |

Mathematics Teachers Responses on Effort Items for content validity

| Respondents | EMQ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 3 | 4 | 2 | 3 | 4 | 3 | 4 | 4 |
| 2 | 1 | 4 | 3 | 1 | 4 | 4 | 2 | 3 |
| 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 4 |
| 4 | 4 | 4 | 3 | 3 | 3 | 2 | 4 | 4 |
| **CVI** | **.75** | **1.0** | **.75** | **.75** | **1.0** | **.75** | **.75** | **1.0** |

$$\text{CVI (EMQ)} = \frac{.75 + 1.0 + .75 + .75 + 1.0 + .75 + .75 + .75}{8} = .84$$

| Item Code | CVI | Remarks |
|---|---|---|
| 1 | .75 | Item accepted |
| 2 | 1.0 | Item accepted |
| 3 | .75 | Item accepted |
| 4 | .75 | Item accepted |
| 5 | 1.0 | Item accepted |
| 6 | .75 | Item accepted |
| 7 | .75 | Item accepted |
| 8 | 1.0 | Item accepted |

Mathematics Teachers Responses on PSAMQ Items for content validity

| Respondents | PSAMQ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 3 | 4 | 1 | 4 | 1 | 2 | 3 | 1 | 4 | 3 | 3 | 3 |
| 2 | 2 | 4 | 2 | 3 | 4 | 1 | 3 | 3 | 4 | 2 | 2 | 1 |
| 3 | 4 | 3 | 3 | 4 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| 4 | 3 | 4 | 1 | 3 | 3 | 3 | 4 | 1 | 3 | 3 | 4 | 3 |
| **CVI** | **.75** | **1.0** | **.25** | **1.0** | **.75** | **.5** | **.75** | **.25** | **1.0** | **.75** | **.75** | **.75** |

$$\text{CVI (PSAMQ)} = \frac{.75+1.0+1.0+.75+.75+1.0+.75+.75+.75}{9} = .83$$

| Item Code | CVI | Comments |
|---|---|---|
| Q1 | .75 | Item Accepted |
| Q2 | 1.0 | Item Accepted |
| **Q3** | **.25** | **Item Discarded** |
| Q4 | 1.0 | Item Accepted |
| Q5 | .75 | Item Accepted |
| **Q6** | **.5** | **Item Discarded** |
| Q7 | .75 | Item Accepted |
| **Q8** | **.25** | **Item Discarded** |
| Q9 | 1.0 | Item Accepted |
| Q10 | .75 | Item Accepted |
| Q11 | .75 | Item Accepted |
| Q12 | .75 | Item Accepted |

**B) Construct Validity**

**B.1.EMQ**

Each item consisted of only one factor and according to conventional rule for factor loadings, items with less than .30 factor loadings were considered to be unimportant. The following factor loadings were obtained from factor matrix (component matrix).

| Item Code | Factor Loadings | Remarks |
|---|---|---|
| 1 | .788 | Item accepted |
| 2 | .770 | Item accepted |
| 3 | .836 | Item accepted |
| 4 | .748 | Item accepted |
| 5 | .810 | Item accepted |
| 6 | .691 | Item accepted |
| 7 | .833 | Item accepted |
| 8 | .682 | Item accepted |

**B.2.SEMQ**

| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q | Q12 | Q13 | Q14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | .326 | .642 | .329 | .549 | .099 | .801 | .563 | .432 | .519 | .213 | .036 | .241 | .604 |
| 2 | .326 | 1.00 | .211 | **-.068** | .273 | **-.112** | .387 | .601 | .257 | **-.057** | .028 | .064 | .206 | .189 |
| 3 | .642 | .211 | 1.00 | .280 | .413 | .315 | .635 | .566 | .723 | .539 | .100 | .228 | .274 | .680 |
| 4 | .329 | **-.068** | .280 | 1.00 | .213 | .211 | .395 | .171 | .174 | .601 | .360 | -.049 | .260 | .338 |
| 5 | .549 | .273 | .413 | .213 | 1.00 | .211 | .510 | .570 | .197 | .392 | .350 | .361 | .328 | .443 |
| 6 | .099 | **-.112** | .315 | .211 | .211 | 1.00 | .180 | .190 | .189 | .169 | .300 | .654 | .495 | .277 |
| 7 | .801 | .387 | .635 | .395 | .510 | .180 | 1.00 | .635 | .453 | .511 | .293 | .092 | .107 | .791 |
| 8 | .563 | .601 | .566 | .171 | .570 | .190 | .635 | 1.00 | .253 | .350 | .046 | .223 | .278 | .514 |
| 9 | .432 | .257 | .723 | .174 | .197 | .189 | .453 | .253 | 1.00 | .356 | .185 | .242 | .244 | .476 |
| 10 | .519 | **-.057** | .539 | .601 | .392 | .169 | .511 | .350 | .356 | 1.00 | .145 | .046 | .127 | .408 |
| 11 | .213 | .028 | .100 | .360 | .350 | .300 | .293 | .046 | .185 | .145 | 1.00 | .110 | .297 | .227 |
| 12 | .036 | .064 | .228 | -.049 | .361 | .654 | .092 | .223 | .242 | .046 | .110 | 1.00 | .555 | .159 |
| 13 | .241 | .206 | .274 | .260 | .328 | .495 | .107 | .278 | .244 | .127 | .297 | .555 | 1.00 | .096 |
| 14 | .604 | .189 | .680 | .338 | .443 | .277 | .791 | .514 | .476 | .408 | .227 | .159 | .096 | 1.00 |

**C) Reliability**

The internal consistence of items was analyzed using alpha of Cronbach.

**i)SEMQ:**Original Cronbach's alpha=.870(Before item deleted)

New Cronbach's alpha=.873(after 1 item deleted)

ii) EMQ: Cronbach's alpha=.902(no item deleted)

Appendix D: Problem Solving Assessment Rubric Measure using Polya's Model

**1. Understanding**

The point 0 was given if students can give no response

The point 1 was given if students responds all inappropriate

The point 2 was given if students miss most part

The point 3 was given if students responds complete and appropriate answers to the given problem

**2. Devising a plan**

The point 0 was given if students can give no repose

The point 1 was given if students respond all inappropriate

The point 2 was given if students miss most part

The point 3 was given if students respond complete and appropriate answers to the given problem

**3. Carrying out a plan**

The point 0 was given if students can give no response

The point 1 was given if students respond all inappropriate

The point 2 was given if students miss most part

The point 3 was given if students respond complete and appropriate answers to the given problem

**4. Looking back**

The point 0 was given if students can give no response

The point 1 was given if students respond all inappropriate

The point 2 was given if students miss most part

The point 3 was given if students respond complete and appropriate answers to the given

Appendix E: Solutions to the problems Using GSP

In $\Delta$ ABC, $\overline{BE}$ and $\overline{CF}$ are altitude of the triangle. If AB= 6 cm, AC=5 cm and CF =4 units, Find the length of BE.

Phase1: Understanding the problem

Read and reread the problem

Identifying the basic information of the problem

Describe the main concepts of the problem

Phase2: Planning (Devising a Plan)

Identifying the rules, principles and techniques of finding areas of triangles and parallelograms, areas and perimeters of segments and sectors

. Open Sketch pad

Choose **Preference** from edit menu and make sure that distance in **cm** and precision **hundredth**

Draw line AB

Take a point C not on line AB

High light the line AB and the point C using **translation arrow** tool.

From Construct menu choose **perpendicular line**. Let F be the point of intersection of line AB and the perpendicular line CF. Similarly draw a line perpendicular to line AC passing through the point B.

Hide the lines and join the points using line segments.

From the graph menu choose **Show Grid.** Hide the two axes and two additional points.

Choose **Snap points** from graph menu. Make AB horizontal so that its length is 6cm.

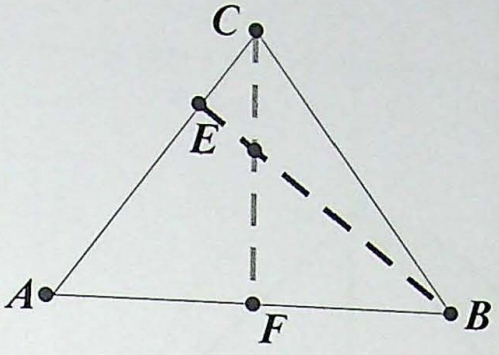
Carrying out the Plan(Solving)

$m\overline{AB}$ = 6.00 cm

$AC$ = 5.00 cm

$m\overline{BE}$ = 4.80 cm

$m\overline{CF}$ = 4.00 cm




Evaluating and Checking back

Checking all the problem pathway

9. Square ABCD is inscribed in a circle of radius 4cm.Find the area of the minor segment cut off by the cord AB.

Phase1: Understanding the problem

Read and reread the problem

Identifying the basic information of the problem

Describe the main concepts of the problem

Phase2: Planning (Devising a Plan)

Identifying the rules, principles and techniques of finding areas of triangles and parallelograms, areas and perimeters of segments and sectors

Open sketchpad

From the **Graph** menu choose **Show Grid. Draw a segment of length of 4cm.**

From **Construct** menu, choose **Circle+ Point** by clicking the end points of the line segment

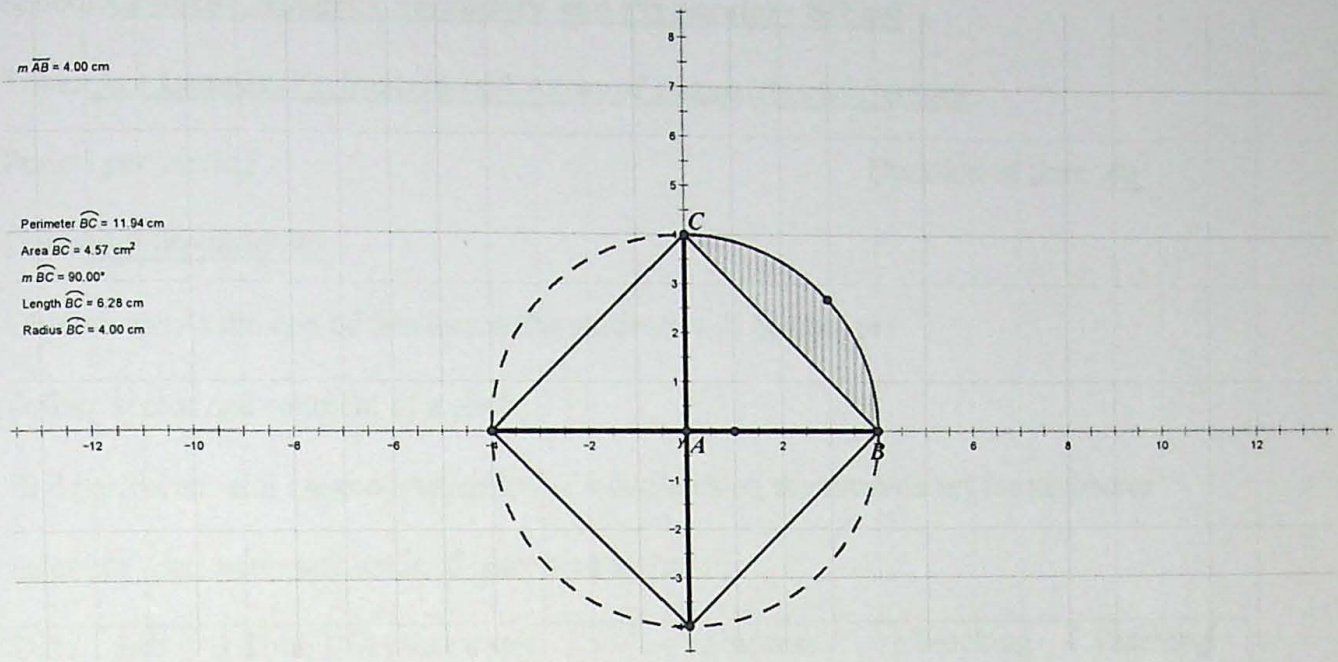
Draw two perpendicular lines containing radii of the circle

Construct a square by connecting the end points of the radii

Choose three points on a circle including the two vertices of a square .from Construct menu, choose Arc on a circle. Then choose interior, Arc segment to shade the segment of the minor arc.

From Measure menu, choose, Area. Now the area of the segment displayed

## Phase3: Carrying out the plan(solving)



Appendix F: Sample lesson plan for traditional paper-pencil Instruction

Teacher,s Name: **Abera kotu** Grade and Section: **9G**

School:**Chancho Abageda Secondary and Preparatory School**

Topic:**Arc Lengths,Perimeters and Areas of Segments and Sectors**

Period per week:**5** Duration of time :**40'**

Date:**04/9/06-08/09/06**

Objectives: At the end of this lesson the students will be able to:

define sector and segment of a circle.

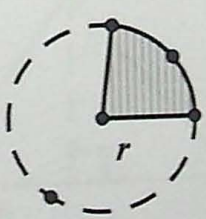
find perimeter and areas of segments of a circle using the formula set for perimeter

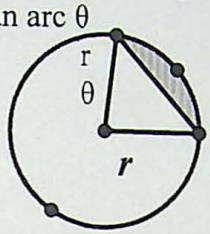
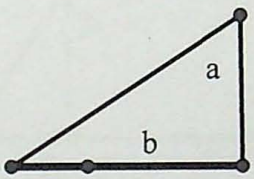
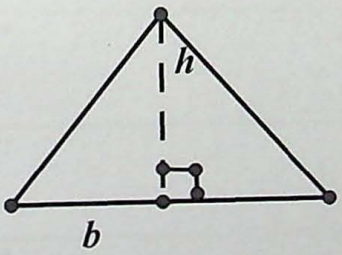
calculate perimeter and areas of sectors of a circle

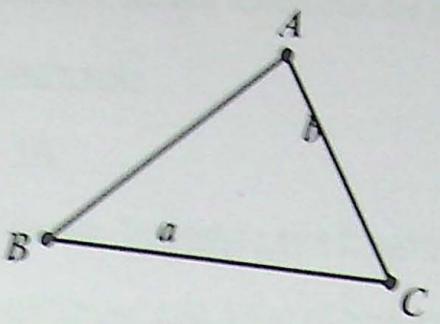
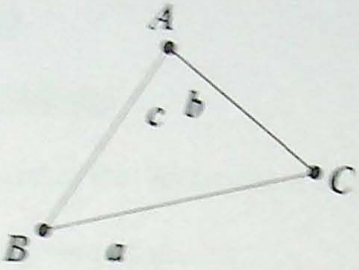
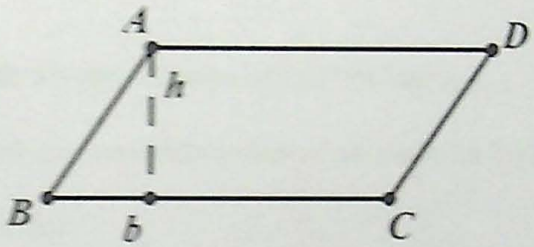
| Date | Sub Topics | Time | Teacher's role | Students' role | Teaching Method | Teaching aids |
|---|---|---|---|---|---|---|
| 11/9/06 | Arc lengths | 5' | Revising previous lesson and introduce the new lesson | Listening | Lecture method | |
| | | 20' | Present the concepts of an arc of a circle and formula to calculated arc lengths | Attending teachers presentation | Discussion method | |
| | | 10' | Summarize the basic concepts of arc lengths | Asking questions | | |
| | | 5' | Giving home Works | Doing home Wirk | | |
| 12/9/06 | The area and perimeter of a sector | 5' | Revising previous lesson and introduce the new lesson | Listening | lecture method | |
| | | 20' | Present the concepts of an arc of a circle and formula to calculate perimeter and areas of sector | Attending teachers presentation | Discussion method | |
| | | 10' | Summarize the basic concepts of perimeter and areas of sector | Asking questions | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 5' | Giving home Works | Doing home Work | | |
| 13/9/06 | The area and perimeter of a sector | 5' | Revising previous lesson and introduce the new lesson | Listening | Lecture method | |
| | | 20' | Present the concepts of an arc of a circle and formula to calculate perimeter and area of sector | Attending teachers presentation | Discussion method | |
| | | 10' | Summarize the basic concepts of areas and perimeters of a sector | Asking questions | | |
| | | 5' | Giving home Works | Doing home Work | | |
| 14/9/06 | The area and perimeter of segments of a circle | 5' | Revising previous lesson and introduce the new lesson | Listening | Lecture method | |
| | | 20' | Present the concepts of an areas and perimeter f segments, formula to calculate areas and perimeter of a segment of circle | Attending teachers presentation | Discussion method | |
| | | 10' | Summarize the basic concepts of areas and perimeter of a segment | Asking questions | | |
| | | 5' | Giving home Works | Doing home Work | | |
| 15/9/06 | The area and perimeter of a circle | 5' | Revising previous lesson and introduce the new lesson | Listening | Lecture method | |
| | | 20' | Present the concepts of an arc of a circle and formula to calculate areas and perimeters of segment | Attending teachers presentation | Discussion mehod | |
| | | 10' | Summarize the basic concepts of areas and perimeters of a segment | Asking questions | | |
| | | 5' | Giving home Works | Doing home Work | | |

**Contents to be taught during four weeks of the treatment**

| Weeks | Period | Contents | Description | Concepts to be taught |
|---|---|---|---|---|
| 1 | 1 | Similarities of Triangles | Two triangles are similar, if their corresponding angles are congruent and their corresponding sides have the same ratio | Proportionality of the ratio of the corresponding sides<br>The congruence of the corresponding sides of similar triangles. |
| | 2 | " | " | " |
| | 3 | " | " | " |
| | 4 | " | If the ratio of the lengths of the corresponding sides of two similar triangles is k, then<br>i)the ratio of their perimeters is k<br>ii)the ratio of their areas is $k^2$ | $A_1$=Area of first triangle<br>$A_2$=Area of similar triangle<br>$P_1$=perimeter of first triangle<br>$P_2$=perimeter of similar triangle<br>i) $\frac{p_1}{p_2} = k$<br>ii) $\frac{A_1}{A_2} = k^2$ |
| | 5 | " | If the ratio of the lengths of any two corresponding sides of two similar polygons is k, then<br>the ratio of their perimeters is k.<br>ii)the ratio of their areas is $k^2$ | i) $\frac{p_1}{p_2} = k$<br>ii) $\frac{A_1}{A_2} = k^2$ |
| 2 | 1 | Arc lengths | An arc is a portion of a circle<br> | The length l of an arc of a circle of radius r that subtends an angle of θ is given by $\ell = \frac{\theta}{360^\circ} \times 2\pi r$<br>or<br>$\ell = \frac{\pi r \theta}{180^\circ}$ |
| | 2 | The area and Perimeter of a sector | A sector is the region bounded by two radii of a circle and an arc. | The area A of a sector of radius r and a central angle θ is given by: |

| | | | | |
|---|---|---|---|---|
| | | | | $A = \frac{\pi r^2 \theta}{360^o}$<br>The perimeter p is given by<br>$P = 2r + \frac{\pi r \theta}{180^o}$ |
| | 3 | The area and perimeter of a sector | " | " |
| | 4 | The area and perimeter of a segment | A segment of a circle is a region bounded by a chord and an arc θ<br> | The area A is given by<br>$A = \frac{\pi r^2 \theta}{360^o} - \frac{1}{2} r^2 \theta$<br>The perimeter p is given by<br>$p = 2r \sin\frac{\theta}{2} + \frac{\pi r \theta}{180^o}$<br>(chord length+ arc length) |
| | 5 | The area and perimeter of a segment | " | " |
| 3 | 1 | Areas of Triangles | <br> | The area A of a right angle triangle with perpendicular sides of lengths a and b is given by:<br>$A = \frac{1}{2} ab$<br>The area A of any triangle with base b and corresponding height h is given by:<br>$A = \frac{1}{2} bh$ |

| | | | | |
|---|---|---|---|---|
| | 2 | Areas of Triangles |  | The area A of any triangle with sides a and b units long and angle C(<C) included between these sides is: $A = \frac{1}{2}ab\sin(<C)$ |
| | 3 | Areas of Triangles | " | " |
| | 4 | Areas of Triangles (Heron's Formula) |  | The area A of a triangle with sides a, b and c units long and semi perimeter s=(a+b+c) is given by: $A = \sqrt{s(s-a)(s-b)(s-c)}$ |
| | 5 | Areas of Triangles (Heron's Formula) | " | " |
| 4 | 1 | Areas of Parallelograms |  | The area A of a parallelogram with base b and perpendicular height h is A=bh |
| | 2 | Areas of Parallelograms | " | " |
| | 3 | Areas of Parallelograms | " | " |
| | 4 | Areas of Parallelograms | " | " |
| | 5 | Areas of Parallelograms | " | " |

Appendix G: Sample lesson plan for instruction with the GSP

Teacher,s Name: **Abera kotu**

Grade and Section: **9H**

School:**Chancho Abageda Secondary and Preparatory School**

Topic:**Arc lengths,perimeter and Areas of Sectors and Segments**

Period per week: **5**

Duration of time: **40**

Date:**04/09/06 - 08/09/06**

Objectives: At the end of this lesson the students will be able to:

define sector and segment of a circle.

find perimeter and areas of segments of a circle using the formula set for perimeter

calculate perimeter and areas of sectors of a circle

**Procedures**

Students began with the introduction of GSP technology

Example of the problem was demonstrated to students by the teacher based on the four stages of Polya's model

Similar problems were given to students

The facilitator provided a limited amount of information on the problems

**Declaration**

I, Abera Kotu Wakjira, hereby declare to Addis Ababa University School of Graduate Studies that this thesis is a product of my original research work, and it has not been submitted and presented to any University for any academic degree and that all source of material used for the thesis have been dully acknowledged.

Name: Abera Kotu

Signature: _____

Date of Submission: 9 Jan, 2015

Department of Science and Mathematics Education, Addis Ababa University

This thesis has been submitted for approval to my advisor

Kassa Michael

Assistant Professor, Addis Ababa University

Signature: _____

Date of submission: _____