UNIVERSITY OF EDUCATION, WINNEBA

USING CONSTRUCTIVIST APPROACH OF TEACHING AND LEARNING TO ENHANCE THE PERFORMANCE OF FORM TWO STUDENTS OF NIFA SENIOR HIGH SCHOOL IN AREA OF QUADRILATERALS

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AUGUST, 2021

DECLARATION

Student's Declaration

I, Vincentia Terkwor Lawer, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: ……………………………………

Date: …………………………………………

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Name of Supervisor: DR. APAWU JONES

Signature: ……………………………………

Date: …………………………………………

DEDICATION

This project is dedicated to the Almighty God for seeing me through successfully. I also dedicate it to my dear and lovely parents, Mr. and Mrs. Kpabi Lawer, my husband, Robert Nartey Barnor, my sister Peggy Lawer, my lovely kids Solange Derdoh and Jayden Nartey and the rest of my family and friends for their prayers and maximum support which have resulted in the successful completion of this thesis.

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To my family and friends, I say God bless you for your encouragement, support and prayers.

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ABBREVIATIONS

GES	-	Ghana Education Service
GSS	-	Ghana Statistical Service
RPK	-	Relevant Previous Knowledge
SHS	-	Senior High school
SPSS	-	Statistical Package for Social Sciences
TLM	-	Teaching Learning Materials

ABSTRACT

The study explored the use of constructivist approach to teaching and learning to improve the performance of students in the Nifa Senior High School in the concept of area of quadrilaterals. The study adopted Constructivism theory. The design for the study was a mix of exploratory and action research design. A sample of forty-two (42) students was selected for study, using convenience and purposive sampling techniques. Data was collected through interview, observation and questionnaires and this was analysed using content analysis, descriptive, and Pearson's correlation coefficient. Results from the study showed that, the constructivist approach to teaching and learning significantly improved the performance of students specifically, in the concept of area of quadrilateral than the conventional approach. Additionally, the constructivist approach helped the students to easily identify the various types of quadrilaterals which helped them in applying the right formula and hence the improvement in their score on the post test conducted. Also, the study revealed that students had improved their understanding of the re-allotment to the concept of area as a result of being taught using the constructivist approach. Again, the latter helped them solve problems involving quadrilaterals more easily. Finally, the study showed a statistically strong positive correlation between the constructivist approach to the learning of mathematics and students' performance. Furthermore, teachers should ask students to explain their solutions because it allows for creativity. Also, teachers must give direct and specific target and instructions during lesson so as to work within the stipulated time as well as achieve stated objectives when using the constructivist approach. Finally, further studies should explore area of quadrilaterals in other schools and use constructivist approach in other subjects.

CHAPTER 1

INTRODUCTION

1.0 Overview

This chapter gives a general understanding to the study. It begins with the background of the study, which highlights the key terms of the understudy. This chapter continues with the problem statement and goes on to talk about the purpose of the study, objectives of the study, the research questions and research hypothesis. Significance of the study follows. Delimitation of the study, limitations of the study and organization of the study is subsequently provided.

1.1 Background of the Study

The world has now become a global village and trends in all human endeavours have assumed new shapes and dimensions. It is therefore important that mathematics as a subject should also be revolutionized in its teaching and learning to meet the challenges demanded of it by the ever-changing world. Teachers in particular, and educational planners in general are therefore implored by society to design practical methods of teaching and learning that are applicable to the learner's environment and our everyday life situations. No nation can attain technological breakthrough without a well-planned and effectively implemented mathematics education programme, since mathematics plays a leading role in all human endeavour (Onivehu & Ziggah, 2006).

Mathematics is one of the basic requirements of education in Ghana right from the basic level. It forms a major entry requirement to the university making the subject a key area of concentration in the Ghanaian education system. Mathematics is made up of branches including arithmetic's, geometry, algebra, trigonometry, calculus etc. Geometry forms a considerable amount of the content of Senior High School

(SHS) syllabus. Kamilombilo and Sakala (2015) posits that, geometry provides a rich source of visualization for understanding algebraic arithmetic and statistical concepts. Geometry is a branch of mathematics that deals with the properties of shapes, points, space, positions or angles, and patterns. Studying geometry helps to develop problem-solving skills as well as spatial reasoning, which can be useful in many industries. Geometry describes two-and three-dimensional objects, life form, and inanimate object "something's"-that we can measure. For example, we can measure the length of a race track, the weight of a pineapple, the area of a of book, the distance around a circle, and the height of a building. Without students' ability to understand size, shape, position and depth, they cannot fully appreciate the natural world (Güven & Kosa, 2008; Yegambaram & Naidoo, 2009)

In order to conceptualize and analyse not only physical but also imagined spatial environments, geometry provides for a complex network of interconnected concepts which require representation systems and reasoning skills (Alex & Mammen, 2016). Geometry is in every part of the school Mathematics curriculum in Ghana running through to the College of education and University level. Since most educational fields use a spiraling curriculum, the concepts are re-visited throughout the classes advancing in levels of difficulty.

In high school, there is a great deal of focus on analysing properties of two- and three-dimensional shapes, reasoning about geometric relationships and using the coordinate system. The study of geometry offers many foundational skills and helps to build the thinking skills of logic, deductive reasoning, analytical reasoning and problem solving (Armah et al., 2018). Moreover, high school geometry builds on elementary school geometry which is usually based on measurement and the informal development of the basic concepts required in geometry at the high school level. The topics on measurements of perimeter, area, and volume which are revisited in the high school curriculum provide excellent opportunities for further applications of algebraic concepts in geometry (Dindyal, 2007). As a result, ensuring students' understanding of geometry is crucial. However, a lot of concerns have been raised about the level of students' understanding of geometry in Ghanaian schools. My observations of senior high students' attitude towards geometry are that of panic, worry and lack of self-confidence. Ghanaian students have internalized the false belief that Mathematics learning including geometry requires an innate ability (Fredua-Kwarteng & Ahia, 2015). Geometry is linked to many other topics in Mathematics, particularly measurement and is used daily by architects, engineers, physicists, land surveyors and many more professionals. In addition, other Mathematical concepts which run very deeply through modern Mathematics and technology, such as symmetry, are most easily introduced in a geometric context. Whether one is designing an electronic circuit board, a building, a dress, an airport, a bookshelf, or a newspaper page, an understanding of geometric principles is required (Yegambaram & Naidoo, 2009).

Teaching geometry at the senior high level should be done in ways that promotes geometric thinking, understanding and eventually application of it. However, it is observed that the teaching and learning culture of Mathematics including geometry in Ghanaian schools have the following characteristics which have contributed to the Mathematics underachievement of Ghanaian students: students accept whatever the teacher teaches them. The teacher is the sole authority of mathematical knowledge in the classroom, while the students are mere receptors of mathematical facts, principles, formulas, and theorems (Armah et al., 2018). Thus, if the teacher makes any mistakes the students would also make the same mistakes as the teacher made. Fredua-Kwarteng and Ahia, (2004) posit that, the teaching culture in most Ghanaian Mathematics classroom has significantly shaped the Mathematics learning. The West African Examination Council (WAEC) Chief Examiner's annual reports for the West African Senior School Certificate Examination (WASSCE) from 2008 to 2011 observed that candidates were weak in 2 and 3-dimensional geometrical problems. In 2011 and 2012, the examiner's report once again revealed candidates' lack of adequate knowledge in geometry and application of geometric concepts.

Atepe (2008) argued that, learners' difficulty with school Mathematics specifically geometry is caused largely by teachers' failure to deliver instruction that is appropriate to the learners' geometric level of thinking. The mathematical term 'area' can be defined as the amount of two-dimensional space taken up by an object. Area measurement has various applications in human life such as determining the area of a land, and finding the number of tiles needed to cover a floor. Packaging of items mostly take the shape of quadrilaterals such as boxes for medicines, sugar cubes, cartoons for packing etc. and the area needs to be known to enable a compact packing.

In this time of mathematics teaching reform, many external governing bodies are encouraging teachers to rely less on explicit teaching methods and rote fact memorization and to focus more on the process of understanding and appropriately applying mathematical concepts. Many teachers, however, may be at a loss as to how to emphasize and assess conceptual understanding in the mathematics class. Evans (1994) as cited in Beernink (2018), stated that "every student can learn, just not on the same day, or in the same way" pg 8. This sentiment is echoed by Albert Einstein who was quoted as saying: "I never teach my pupils; I only attempt to provide the conditions in which they can learn" (Hansen, 2000). The challenge in teaching is to create experience that involves the student and support his or her own thinking explanation, evaluation, communication and application of the scientific models needed to make sense of these experience (Nwagbo, 2006). Consequently, this calls for the constructivist approach of teaching which involves guiding students to seek information. Every student needs a champion–someone to believe in them when their own conviction falters. Teachers serve as facilitators of learning which students are encouraged to be responsible, autonomous and construct their own understanding of each scientific concept. Hence the activities are learner centred, democratic and interactive (Hansen, 2000). Nwagbo (2006) also believe that if the learner is allowed to discover relationships and methods of solution by himself or herself, makes his or her own generalizations and draws conclusion from them, he or she may then be better prepared to make wider application of the material learned. According to Ugwuanyi (1998), a learner is active in discovery learning and provides for individual differences as well as makes the process of learning to be self-sequenced, goal directed, with the goal perceived and pace self-determined (Purba, 2013).

In a traditional teaching approach, mostly teachers only give the procedural algorithms or formulas to determine areas of geometrical shapes. Students tend to memorize the formulas such as the area of a rectangle is $base\ x\ height$ ($A = b\ x\ h$). Cavanagh (2007) states teaching and learning of area measurement will not be successful if it focuses too much on formulas instead of conceptual understanding (Sneider & Kavanagh, 2006). Thus, under the traditional mathematics learning approach, the student only memorizes formulas and apply them without understanding the concept, how and why the formula works. As a result of this teaching approach, students do not understand the concept of area and face several difficulties in learning area measurement or in learning how to measure areas. Some studies have revealed that students at all levels experience difficulties dealing with area concepts (Sneider & Kavanagh, 2006). Students think that an irregular figure does not have an area with the justification that the shape is strange and also it has too many sides (Sneider & Kavanagh, 2006). Hirstein et al. (1978) (as cited in Cavanagh, 2007) reported in their study that elementary school students counted all regions equally regardless of their geometrical shape when using a grid.

Zacharos and Chassapis (2012) also argued that the lack of understanding of the mathematical concepts is due to the use of traditional teaching methods overstressing formulas and algorithms without giving attention to students' comprehension of the concepts. Related to area measurement, Martin and Strutchens (2000) (cited in Kamii & Kysh, 2006) stated that the concept of area is often difficult for students to understand, and that this is perhaps due to their initial experiences in which it is tied to a formula (such as length × width) rather than more conceptual activities. Zacharos (2006) stated that research in the field of mathematical education often reveal poor understanding of how to measure area of plane figures.

This study therefore sought to investigate students' understanding of area measurement using the constructivist approach by focusing on the concept of conversation of area integrated with unit measurement to support students to understand area formulas to measure area of quadrilaterals in secondary school. This study used "re allotment" which is the act of reallocation or redistribution of something by cutting and pasting. In measurement of area, reallotment reshapes a figure into another one without changing its area. In other words, the area of a figure remains the same when it is reshaped. In addition, different shapes would possibly have the same area. The concept of unit of measurement through the tiling activity will support students to understand the formula of area of rectangles.

From the activity of reshaping the other quadrilaterals and triangles into a rectangle, students understood how the formular of area of quadrilaterals were derived from the formula of area of rectangle. Reshaping into a rectangle helped students to derive the other formulas of area of quadrilaterals.

It is against this background that the study sought to investigate how constructivist approach could help students to improve on their performance in finding the area of quadrilaterals.

1.2 Statement of the Problem

Effective knowledge in Science and Mathematics is the basis for human development in all areas of life. In Ghana, the Curriculum Research and Development Division (CRDD) of the Ministry of Education and Sports (MOES) recommends the use of educational resource materials for investigation and solving problems of real-life situations (Ministry of Education and Sports, 2007). The use of educational resource materials for investigating and solving problems of real-life situations help make teaching and learning. However, these materials are significantly missing in the High School mathematics. Curriculum is the specified type of the educational materials to use and at what time and place to use them as well as the topics for which they are to be applied. Most teachers are at a loss at when and where to use these educational materials for effective teaching and learning. Curriculum is the specified type of the educational materials to use and at what time and place to use them as well as the topics for which they are to be applied. Most teachers are at a loss at when and where to use these educational materials for effective teaching and learning. What most teachers do therefore, is to teach major topics in mathematics without the necessary material inputs that could give better understanding of the topics.

Form two students of Nifa senior high school can state the formula of finding the area of a square and rectangle but cannot apply it in solving related problems. Area measurement has various applications in human life such as determining the area of a land, and finding the number of tiles needed to cover a floor. Area measurement is also related to other materials such as the multiplication of fractions, enlargement and similarity (Cavanagh, 2007). In integral calculus, to find an area under a curve can be estimated by the sum of areas of rectangles under the curve. A good understanding of the concepts of area is important in learning integral calculus (Cavanagh, 2008). Some studies that have been conducted about area measurement topic show that students in all levels experience difficulties in dealing with area concepts (Cavanagh, 2007). In addition to this, learning by memorizing formulas and applying them will not support students' understanding of the concept of area (Esra & Şükrü, 2017).

According to Zacharos and Chassapis (2012), the lack of understanding of the mathematical concepts is due to the use of traditional teaching methods overstressing formulas and algorithms without giving attention to students' comprehension of the concepts. In relation to the area measurement, Martin and Strutchens (2000) (cited in Kamii & Kysh, 2006) state that the concept of area is often difficult for students to understand, and that this is perhaps due to their initial experiences in which it is tied to a formula (such as length × width) rather than more conceptual activities. Zacharos (2006) states that research in the field of mathematics education often reveal poor understanding of the processes used for area measurement of plane figures.

In this era of education, educational stake holders are encouraging teachers to rely less on explicit teaching methods and rote fact memorization and to focus more on the process of understanding and appropriately applying mathematical concepts.

The study by Mireku (2010), who investigated primary and junior high school teachers' attitude towards, various teaching methods used in the mathematics class, revealed that the difficulties students have in the mathematics subject is due to the ineffective teaching methods and lack of teaching / learning materials in the Ghanaian classrooms and this is also common in the senior high schools. Singer (2011) explains that students honestly do not care about the measures and the best way to learn is through self-interest and curiosity.

The way most students learn geometry is by memorizing the formulas and spitting it out when required for a test especially for grades. Also, failure of teachers to explain or use the right method in teaching and lack of enough practice by students' causes' failure in geometry class. Harry (2000) posits that, one remedy to the problem could be that, that, if they can not learn the way I teach, can I teach the way they learn? Nwagbo (1999) also believes that if the learner is allowed to discover relationships and methods of solution by himself or herself, makes his or her own generalizations and draw conclusion from them, he or she may then be better prepared to make wider application of the material learned. According to Ugwuanyi (1998), a learner is active in discovery learning and provides for individual differences as well as makes the process of learning to be self-sequenced, goal directed, with the goal perceived and pace self-determined. Ferguson (2010), recommended that the inquiry-based method of teaching should be encouraged by administrators and embraced by teachers in an effort to improve education.

Constructivist approach focuses on the learner; thus, it allows the student to search, conclude and generalize on their own. The characteristics of constructivist approach of teaching is as follows;

1. The learners are actively involved
2. The environment is democratic
3. The activities are interactive and student centered
4. The teacher facilitates the of learning process and encourages students to be responsible

1.3 Purpose of the Study

The purpose of the study is to assess how the use of constructivist approach of teaching and learning can improve performance of senior high students specifically in relation to the concept of area of quadrilaterals.

1.4 Objectives of the Study

The Objectives of the study were:

1. To examine student's geometric knowledge of mathematical concepts in area quadrilaterals using constructivist approach of teaching and learning
2. To examine in-depth understanding of the concept of area of quadrilaterals using constructivist approach
3. To determine how students apply the knowledge acquired in the concept of area of quadrilaterals to solve related problems using appropriate procedure
4. To investigate the feasibility of the use of constructivist approach of teaching and learning area of quadrilaterals in Senior High School

1.5 Research Questions

The study sought to address the following research questions;

1. To what extent does, constructivist approach of teaching and learning enhance students' knowledge in area of quadrilaterals?
2. To what extent does, the use of constructivist approach of teaching and learning enhance the performance of students in area of quadrilaterals?
3. How do students apply the concept of area of quadrilaterals in solving related problems area?
4. How feasible is the use of constructive approach of teaching and learning of area of quadrilaterals in S.H.S?

Hypothesis

H_o: There is no statistically significant difference in students' performance using constructivist approach of teaching and learning.

H_1: There is statistically significant difference in students' performance using constructivist approach of teaching and learning.

1.7 Significance of the Study

The various activities in the intervention that students would be taken through would equip them with both practical and intellectual experiences to help them to reduce their difficulties on application on area of quadrilaterals. Again, the research will promote and sustained students' interest to learn as well as motivate slow learners to improve upon their learning. It will serve as a guide and reference to help teacher adopt good practices in teaching area of quadrilaterals.

As the school curriculum is a major factor in shaping the quality of education (CRDD, 2007), the findings that will come out of this study can be used to help curriculum developers and mathematics teachers on how to use the constructivist approach in order to improve the interest of students in mathematics and specifically geometry. Moreover, the research would help dispel students' general negative perceptions about mathematics and geometry in particular which would influence their learning of the subject positively.

It is hoped that this research will in turn sustain interest in geometry as students' progress to higher classes and make them derive the full benefit of having a good basics and knowledge of geometry.

The results of this study would help to sharpen most students' analytical skills in understanding area of quadrilaterals. It would promote and sustain students' interest to learn geometry as well as motivate slow learners to improve upon their learning.

It will also add to the existing body of knowledge in teaching and learning of geometry. Other researchers can also use it as reference for further similar studies. The researchers' work will inform, educate and sensitize teacher trainees to develop confidence and greater interest and cultivate positive attitudes towards the teaching and learning of geometry.

1.8 Delimitation of the Study

The study focuses on what goes on in the Nifa Senior High School specifically among Form 2 students instead of looking at the entire student body of the Nifa senior high school or the country at large, hence its application to the entire student body or the country at large may not be reliable. In addition, this current study only focuses on the mathematics and to be more specific to just the concept thus area of quadrilateral, hence its application to other concepts in mathematics or other field of study may not be reliable as well.

1.9 Limitations of the Study

Limitations of a study are those conditions beyond the researcher's control that are likely to place restrictions on the findings or conclusion of the study and the generalizations of the findings (Ravitch & Riggan, 2017).

The major limitation to the study was the small number of participants. Other limitations were the single class (2B1) used for the study and the scope of the quadrilaterals topic used in the study. The interference of unplanned school activities was also a draw back

1.10 Definition of Terms

For the purpose of this study, the following operational definitions was used;

Constructivist: include personal construction of meaning by the learner through experience, and that meaning is influenced by the interaction of prior knowledge and new events.

Performance: It is the end result of the efforts exerted by the students. It represents outcomes that indicate the extent to which a person has accomplished specific goals.

Quadrilateral: A four-sided object. A quadrilateral is a closed figure with four straight sides. It can be made by taking (or imagining) anything straight and thin you might have handy.

Area: refers to the space the base of an object occupies.

Students: refers to a learner in the senior high school.

1.11 Organisation of the Study

The whole study was organized in five main chapters. The first chapter deals with the background to the study, the statement of the problem, the purpose of the study, hypothesis, research questions and significance of the study, delimitations, and the definition of terms.

The second chapter critiques related literatures that are relevant to the study. It considers the previous studies on the topic. It includes other areas like, theoretical framework, overview of teaching and learning, learning and learning theories, constructivist and theories, definitions and classifications of quadrilaterals and related studies on constructivists approach to teaching and learning of mathematics.

Chapter three focuses on the methodology, describes for the reader important components of this study, such as research philosophy, research approach, research design, population, sample and sampling procedure, source of data, research instruments, validity research instruments and reliability of research instruments, trustworthiness of the interviews, data collection procedures, data analysis procedures and ethical consideration

Chapter four deals with data analysis and presentation, and finally, the fifth chapter covers discussion, summary of the major findings, conclusions, recommendations and suggestions for future studies.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

This chapter reviews literatures pertinent to the current study. A literature review describes the systematic processes of searching for scholarly works (Ridley, 2012), critical review of scholarly works (Hart, 2018), and discussion of published information (Hart, 2018). Typically, a literature review has an operational structure incorporating description and thesis synthesis. The literature review essentially explains the whole process of the analysis, including acting as a guide for analysing research data and explaining research findings (Hart, 2018). Data pieces for this review were gathered from journals, abstracts, internet, books, and works on constructivist approach to teaching and learning as well the concept of area of quadrilateral. It is organized under the following sub-headings:

a. Theoretical Framework
b. Overview of teaching and learning
c. Learning and learning theories
d. Constructivist and theories
e. Definitions and classifications of quadrilaterals
f. Related studies on constructivists approach to teaching and learning of mathematics
g. The Concept of an Area
h. Students' understanding and misunderstanding of the concept of area.

INTRODUCTION

In the book, Making Sense: Teaching and Learning Mathematics with Understanding, author James Hiebert and his coauthors offer a number of insights about teaching for understanding. The analyses presented in the book were based on data and observations obtained in four research and development projects that the coauthors directed. Though the research that went into these projects took place in various elementary-schools around the world, the authors state their intent of preparing and presenting conclusions that may be applied to any mathematical topic. Findings from the projects were compared and examined over a period of five years. In this time, the authors created a consensus concerning the features that make up a classroom that encourages understanding.

The authors argue that tasks are an important way for students to learn, because they aid them in thinking and discovering on their own. They offer the following set of criteria that help to define how tasks should be conceived: First, the tasks must allow the students to treat the situations as problematic, as something they need to think about rather than as a prescription they need to follow. Second, what is problematic about the task should be the mathematics rather than other aspects of the situation. Finally, in order for students to work seriously on the task, it must offer students the chance to use skills and knowledge they already possess. (Hiebert 1997) Students get involved in problems that are interesting to them. A problem becomes interesting when students are able to claim it as their own. Students will work toward solving a problem if they have a personal investment in the situation. They should not be enticed to solve problems for an outside reward, like candy or free time; they should have self-interest in the outcome of the problem.5

The most interesting part about a task should be the math that goes into it and not the task itself. The authors explain that tasks should also allow students to use tools they are familiar with. They describe tools as tangible things that students work with, or methods they are comfortable with. Either way, tasks should encourage students to use previous knowledge to solve new problems or create new outcomes. Students do not do this by watching others, they learn by personal experience. They must therefore be allowed to play around with and explore the tools they have. Educators should prepare suitable problems for the tools that are available. Hiebert et al. explain that it is important that tasks leave behind a "residue" of learning (Hiebert 1997). Thus, tasks should be strategically planned to lead students to think and reflect about important topics as they pursue the goals of the task. Students who make connections and leave a task with an understanding are more likely to make other connections later on. In contrast, students who learn through memorization have a difficult time connecting concepts and procedures. When creating a task, the teacher must think of the process his or her students will be involved in and what they will ultimately take away. One of the most difficult things about task-based learning, according to the authors, is that the teacher has to change his/her role in the classroom. It is important for teachers to step aside and allow students to struggle and work through rough patches in the task. Teachers need to find a balance, where they can guide discussion without getting too involved. A total handsoff approach is unrealistic.

If students are left on their own, there could be little discovery taking place and a great deal of frustration. There is no rule for teachers to follow in order to create this balance, each classroom is different and has to develop its own environment. The main role of the teacher is to plan and create tasks that produce understandings that can be used in the future. Teachers should not only plan based on the goals that are to be 6 achieved in the present task, they must also keep in mind future tasks and goals and how they will tie together and be meaningful for the student. Since student understanding is a growing process, students should be able to build from one task to the other and use the “tools” from previous tasks to complete future ones. If teachers are successful at planning tasks in this manner, students will see the flow of concepts throughout the course instead of distinct individual activities. Teachers select tasks based on knowledge of mathematics together with knowledge of their students. Knowing the material means that teachers are comfortable moving around the curriculum and are able to connect topics. Teachers must also be familiar with how their students think. This is important because teachers must be aware of the tools that their students possess, how their students will approach a task and what their students will take away from it. The authors take on the big question of how much should educators tell. Their answer is, teachers should share information as long as it does not get in the way of student problem solving. Students should have room to reflect and explore without teacher interference.

One way in which teachers can share information is by providing useful methods for recording and communicating mathematical ideas. Students have their own language and terminology, even in the mathematics classroom, but teachers can provide symbols and terminology that make the writing and communicating process shorter and more efficient. Teachers must be careful in how they present these things. What is provided should act as an aid and should not burden students. Another way teachers can intervene is by presenting alternate methods for solving problems. Teachers must be careful in how they do this, so that students do not view the teacher’s method as the “right method”. Teachers can avoid this by introducing methods from other students and suggesting modifications for offerings that may be flawed or in need of 7 improvement. Students should be able to use their own methods and should not need to worry about reproducing the teacher's way. A third way teachers can share information is by clarifying the major concepts involved in a task. Students may begin to grasp these concepts, but the teacher can shape this early understanding into something students are able to use. Again, it is important that the teacher be very careful in how they approach this. Students should value their findings as their own, so it is important that the teacher clarify methods and not make students feel like they are changing their own method. Hiebert and coauthors also discuss the characteristics of a classroom environment that is conducive to task-based learning and the manner in which students and teachers should behave socially in this environment. Students should respect one another and value one another's ideas Communication and reflection should be encouraged.

Three chapters of the book are dedicated to portraying cognitively guided classrooms, conceptually based classrooms, and problem centered classroom, three different styles of instruction that incorporate task-based learning. Stepanek (2000) considers the problem of building effective teaching and learning practices that work in harmony with state standards. The intent of her article is to provide teachers with research-based strategies to create classrooms conducive to learning with understanding. The article acknowledges input and guidance from many educators in science and mathematics. The main theme is the importance of "learning communities" within a classroom in creating an environment suitable for rigorous learning. The author details the different kinds of relationships that can be created between teacher and student. According to this article, to increase learning with understanding, it is important for students to be in a classroom where the teacher is not the center of discussion and learning, but the students share control over the conversation. 8 Stepanek emphasizes importance of establishing classroom norms, developing relationships suitable for learning, and maintaining respect. She describes a number of strategies: the democratic classroom, the caring classroom, and the ecological classroom. Stepanek goes into great detail on the options teachers have in developing learning communities. She describes reflection and collaboration as a great tool. The way a teacher collaborates with his/her students will change every year as a new group of students arrives. It is important that he/she reestablish positive collaborative relationships each year. It is also important that teachers keep a collaborative relationship with their colleagues as well.

Teaching can be challenging, so it is important to keep a learning community among teachers to aid each other as situations arise. In their article, Lucia Grugnetti and Francois Jaquet (1996) discuss the importance of problem solving in the mathematics classroom. The emphasis is placed on how students should solve problems and how teachers can prepare their students as problem solvers. It is important to present students with a problem that is just within their reach, but that challenges the way they think. How a problem is picked apart by a student varies, but the use of strategies, such as group work and technology, can aid the process. One principle for problem solving is the use of a "knowledge-constructing activity" (Grugnetti 1996). There are a series of steps a student should undergo to complete the thought process required for the problem. Grugnetti and Jaquet also discuss the French practice of "situations-problemes." There are five steps that the students must take: the student begins alone, constructs new knowledge, makes a number of trials and conjectures, self-corrects, and develops new knowledge expected by the teacher (Grugnetti 1996).

2.1 Theoretical Framework

The study adopted Constructivism theory. The constructivist approach was originally founded by Piaget and Bruner based on the belief that existence of cognitive schemes are developed through coordination and incorporated in a person's action on the realities in the world (Wadsworth, 1996). Constructivism is a theory that suggests that learners construct knowledge out of their experiences which are associated with pedagogical approaches that promote learning by doing or active learning (Afolabi & Akinbobola, 2009). Constructivist teaching focuses on independent learning, creativity, critical thinking and problem solving skills. Constructivist teaching is based on the facts that skills and knowledge acquisition are not by passive receiving of information and rote learning but involve in active participation of the learning through knowledge construction, hand-on and minds-on activities (Akinbobola& Ado, 2007).

Constructivists are of the view that students should be engaged in active learning process and that the teacher's role is to assist (Piaget & Inheder, 1960). Students should be given the opportunity to explore a problem, try out solutions, build on this new knowledge to make adjustments and involve new solutions. At the concept of constructivist philosophy is the belief that knowledge is not given but gained through real experiences that have purpose and meaning to the learner and the exchange of perspective about the experience with others (Piaget & Inhelder, 1969; Vygotsky, 1978).

One of the primary goals or objectives of using constructivist teaching is that students learn best by creating a conducive environment to tap their experiences and initiations. According to Audrey Gray (1997) the constructivist classroom teaching is as follows:

1. The learners are actively involved
2. The environment is democratic
3. The activities are interactive and student-centred
4. The teacher facilitates process of learning in which students are encouraged to be responsible and autonomous

A constructivist learning intervention is thus an intervention where contextualized activities (tasks) are used to provide learners with an opportunity to discover and collaboratively construct meaning as the intervention unfolds (Apawu, 2011). This theory view learners as unique individuals, and teachers as facilitators. In this study, the researcher was a facilitator and the students constructed their own knowledge on the concept of area. This theory argues that learners should be made responsible for their own construction of knowledge through active participation in guided materials and activities (Educational Broadcasting Corporation, 2004). Thus, the learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. The instructor should try and encourage students to discover principles by themselves. By so doing, instructor and student engaged in an active dialog (i.e. Socratic learning). The task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding. Curriculum was organized in a spiral manner so that the student continually builds upon what they have already learned.

Bruner (1966) states that a theory of instruction should address four major aspects: (1) predisposition towards learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishments. Good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. In his more recent work, Bruner (1986, 1990, 1996) has expanded his theoretical framework to encompass the social and cultural aspects of learning as well as the practice of law.

Bruner's constructivist theory is a general framework for instruction based upon the study of cognition. Much of the theory is linked to child development research (especially Piaget). The ideas outlined in Bruner (1960) originated from a conference focused on science and math learning. Bruner illustrated his theory in the context of mathematics and social science programs for young children (Bruner, 1973). The original development of the framework for reasoning processes is described in Bruner, Goodnow and Austin (1951). Bruner (1983) focuses on language learning in young children. In Burner (1973), the concept of prime numbers appears to be more readily grasped when the child, through construction, discovers that certain handfuls of beans cannot be laid out in completed rows and columns. Such quantities have either to be laid out in a single file or in an incomplete row-column design in which there is always one extra or one too few to fill the pattern. These patterns, the child learns, happen to be called prime. It is easy for the child to go from this step to the recognition that a multiple table, so called, is a record sheet of quantities in completed multiple rows and columns. Here is factoring, multiplication and primes in a construction that can be visualized. The researcher chooses this approach because of the belief that it is perceived as a knowledge constructor.

The constructivist teacher sets up problems and observes learner exploration, guides the direction of learner inquiry and promotes new patterns of thinking. Seminars can take unexpected turns as learners are given the autonomy to direct their own explorations. In a constructivist workshop setting; learners' autonomy and initiative are accepted and encouraged, the teacher asks open-ended questions and allows wait time for responses, higher-level thinking is encouraged, and learners are engaged in dialogue with the teacher and with each other.

According to the social constructivist approach, instructors at a seminar have to adapt to the role of facilitators and not teachers (Apawu, 2011). Where a teacher gives a didactic lecture, which covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. In the former scenario the learner plays a passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, and towards the learner. This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher. A further characteristic of the role of the facilitator in the social constructivist viewpoint is that the facilitator and the learners are equally involved in learning from each other as well (Holt & Willard-Holt, 2000).

In this current study, the researcher did not impose anything on the students but rather was a facilitator and guided the students to construct their own knowledge. A facilitator is thus someone who should be able to adapt the learning experience by using his or her own initiative in order to steer the learning experience to where the learners want to create value.

The Theoretical Assumption of Constructivist Teaching What is the theoretical assumption of constructivist teaching? There are three fundamental differences between constructivist teaching and other teachings. Firstly, learning is an active constructive process rather than the process of knowledge acquisition. Secondly, teaching is supporting the learner's constructive processing of understanding rather than delivering the information to the learner. Thirdly, teaching is a learning-teaching concept rather than a teaching-learning concept. It means putting the learner first and teaching is second so that the learner is the center of learning. Who argues for these assumptions? The constructivists such as Jonassen (1990) and others enlist the following theoretical assumptions (Kim, 1993): Firstly, knowledge is constructed out of sensual and perceptive experiences of the learner in which learning is internalize through the learner's constructive process in nature. Secondly, knowledge is the personal understanding of the outside world through personal experience rather than the experiences of others. Thirdly, this internally represented knowledge becomes the basis of other structures of knowledge and a new cognitive structure of the person. Fourthly, learning is an active process of developing meaning based on individual personal experiences. In other words, learning is a developing process by the learner's understanding of the real world. Fifthly, it comes from the premise that personal understandings result in various perspectives. The perspectives constructed within the individual cognitive conceptual structure attempt to share all possible various perspectives. Sixthly, learning creates knowledge in the context of a situational reality. Knowledge is the understanding of meaning through situational contexts, not objective reality.

2.1.1 Examples of constructivist activities

This is contrary to the traditional classroom where students work primarily alone, learning is achieved through repetition, and the subjects are strictly adhered to and are guided by a textbook. Some activities encouraged in constructivist classroom are:

Experimentation: students individually perform an experiment and then come together as a class to discuss the method.

1. Research projects: students research on a topic and present their findings to class.
2. Field trips: this allows students to put the concepts and ideas discussed in class in a real-world context. Field trips will often be followed by class discussions.
3. Films: this provides visual context and thus bring another sense into the learning experience.
4. Class discussions: this technique is used in all of the methods described above. It is one of the most important distinctions of constructivist teaching methods. Nwagbo (1999) explains that in guided discovery mode, which is an example of constructivist learning, is an approach to enquiry, the teacher provides instructive materials for students to study on their own. Leading questions are then asked by the teacher to enable students think and provide conclusions through the adoption of the scientific process.

2.2 Overview of Teaching and Learning

Teaching, according to Smith (2000), involves teachers facilitate two types of information: knowledge and skill. An attitude is often thought to change as a result of learning and that it represents the outcome from the gain of knowledge and skill. The balance between these two items and attitude is an important aspect of teaching. The ultimate goal of teaching is to facilitate learning in students. Teaching, according to Alton-Lee (2003), is a pedagogical practice that facilitates for heterogeneous groups of students, their access to information and ability to engage in classroom activities and tasks in ways that facilitate learning that is related to curriculum goals. Teaching is considered by Santrock (2001) as a cluster of activities that are noted about teachers with respect to terms such as explaining, deducing, questioning, motivating, taking attendance, keeping record of works, students' progress and students' background information.

Moreover, Tuan (2009) views teaching as the logical and strategic act that denotes the interaction between the teacher and the student as they operate on some kind of verifiable facts and beliefs; and it encourages students' participation and expression of their own views. Sherif (2003) also describes teaching as the facilitation of student learning, imparting knowledge or skill and an activity that induces learning. These definitions imply that teaching is any activity that manipulates a student's environment in order to facilitate learning or behavioural change; it involves imparting verifiable facts and beliefs; it encourages students' participation and expression of their own views. In another way, teaching can be defined as a means to cause the child to learn and acquire the desired knowledge and skills that are desirable for living in the society. Teaching involves the teacher, the learner, the curriculum and other variables that are organized in a systematic and psychological way to attain some pre-determined goals.

The epistemological base of constructivist teaching comes from an epistemological difference between the traditional epistemology of knowledge and the constructivist epistemology of knowledge. Traditional epistemology views knowledge as an objective phenomenon while the constructivist views knowledge as a subjective understanding of the person. In the early 18th century, an Italian philosopher Giambattista Vico defined knowledge as a cognitive structure of a person so that to know something is to know how to create (von Glasersfeld, 1989). The concept of Vico's view was not readily accepted by contemporary western philosophers until the German philosopher Immanuel Kant who had tried to transform the western epistemological tradition of the late 18th century in his book The Critic of Pure Reason (1999). Kant believed that the nature and limits of human knowledge is not possible to find such evidence out of a few cases as long as we continue to think of the mind and its objects as separate entities. He held instead that the mind is actively involved in the objects it experience. That is, it organizes experience into definite patterns.

Therefore, we can be sure that all things capable of being experienced are arranged in these patterns, even though we may not yet have experienced them. He seems to attempt to coordinate two disparate views of knowledge: The view that logical analysis of action and objects leads to the growth of knowledge and the view that one's individual experience generates new knowledge. Kant went on to argue that both views have their own merit such that analysis, by definition, occurs after the facts, and individual experience occurs before or during the event. Both are a function of one's own idiosyncratic mental filtering system. These views affect how one makes sense of new information. Pragmatic philosopher John Dewey, in his Democracy and Education (1916), defined education as a process to restructure the individual experience by reflective thinking through expanding one's present experience. Individual experience is the core of knowledge, not knowledge offered by others. Thus, continuous development of the child must be stimulated through his interaction to his environment to create meaningful knowledge. Thomas Kuhn, in his book, The

Structure of Scientific Revolution (1962) warns against scientific misconceptions and claims a scientific paradigm shift. His paradigm shift in science is similar to the adaptive process offered by Jean Piaget, one of the most influential epistemological constructivists.

The Psychological Base of Constructivist Teaching Jean Piaget (1976), in his book To Understand is to Invent: The Future of Education (1973) states that the growth of knowledge is the result of individual constructions made by the learner's understanding.

Piaget contends that the current state of knowledge is temporal, changing as time passes as knowledge in the past has changed, it is not a static instance; it is a process. It is a process of continual construction and reorganization. Piaget viewed constructivism as a way of explaining how people come to know about their world. He collected an extensive body of research of children's behaviours and witnessed children's behaviours which then use to create well-supported inferences about the function of the mind. Lev Vygotsky (1978) in his Mind in Society outlined how thought and language are independent and develop separately, but with similar processes. He also offers pointers for instructional technologists. Vygotsky analysed a number of studies to help develop his theories of thought and language. He took the strengths of those studies to form his theories, and then tested his theories in his own studies. His theories were influenced by Piaget in which he wrote about the development of thought and speech. Throughout his book he made statements about instruction that have been compiled to connect how instructional technologist can benefit from Vygotsky's analysis and studies. He wrote that a child develops thought and speech separately before two years of age and then s/he merges and joins these functions at two years to initiate a new form. Thought becomes verbal, and speech becomes rational. Speech serves the intellect as thoughts are spoken. Social environment is important to a children's development because it can accelerate or decelerate development. Although Vygotsky did not emphasize the zone of proximal development (ZPD) in this book; the ZPD is relevant to instructional technologists. Since instruction should precede development, the requisite functions are immature when instruction begins. The discrepancy between children's actual mental age and the level they reach in solving problems with assistance is the ZPD. There is no single ZPD for individuals because the zone varies with culture, society, and experience. Vygotsky claimed that the larger the zone, the better students will learn in school. For a ZPD to be created there must be a joint activity that creates a context for student and expert interaction. The expert may then use multiple instructional strategies. Social interaction is important because the expert can model the appropriate solution, assist in finding the solution, and monitor the student's progress. Vygotsky believed that partners should jointly solve problems to bring about cognitive development. Computer programs can be designed by the expert to help the students reach their potential in their ZPD in many ways.

2.2.1 Concept of teaching

According to Smith (2017), teaching is a system of action involving an agent, an end in view, and a situation including two sets of factors-those over which the agent has no control (such as class size, size of classroom, physical characteristics of pupil) and those that the teacher can modify (such as ways of asking questions or ideas gleaned). Smith therefore defines teaching as undertaking certain ethical tasks or activities, the intention of which is to induce learning. Tamakloe, Amedahe and Atta (2005) have defined teaching as directing knowledge towards the learner.

To Kochhar (2004), teaching is not a mechanical process but a rather intricate, exacting and challenging job. Though teaching is poorly paid, Kochhar explains that its riches are of a different order, less tangible but more lasting - that is satisfaction of personal fulfilment. Farrant (1996) explains teaching as a "process that facilitates learning". Teaching and learning are therefore described as the two sides of a coin because teaching does not happen without a learner (Amissah, Sam-Tagoe, Amoah and Mereku, 2002). Some other definitions given to teaching by Amissah et al are as follows:

1. Teaching is the means whereby an experienced member of a group guides and directs pupils in their total growth and development.
2. It is also the activity that the teachers demonstrate to reflect their philosophy of education.
3. Teaching is an interpersonal influence aimed at changing the way or behaviour in which other persons can or will behave.
4. It is a system of actions intended to induce learning.
5. It is an activity aimed at the achievement of learning and practiced in such a way as to respect the learner's intellectual integrity and capacity.

The above definitions show how teaching has been subjected to a variety of descriptions and definitions. While some authors describe teaching as an art because it gives the teacher an opportunity to do something creative like moulding personalities and the mind, others describe teaching as a science because it hinges on a specified body of knowledge - psychology. In this sense, Kochhar (2004) asserts that "teaching is a complex art of guiding pupils through a variety of selected experiences towards the attainment of a widening field of learning". Hence teaching directs growth and development. As the art involves the mind, the heart and the hand, so is teaching (Amissah et al., 2002).

The authors assert that teaching is the art of inducing students to behave in such ways that are assumed to lead to learning. This connotes that teaching is all about creativity because the personality is at play. It is out of passion that a person can teach effectively and it takes a creative teacher to impact on the learner. Therefore teaching can be defined as the art and a conscious act of transmitting knowledge, skills, attitude and values in a systematic and an orderly procedure to induce learning for positive growth and development.

A good teacher is one who knows the capabilities of his learners and has understanding of what his or her students need to learn. This implies that the skill of teaching lies in knowing who, what and how to teach and above all to be able to judge when (Farrant, 1996). Good teaching demands great skill irrespective of the level of teaching. It does not depend on the learner any more as Amissah et al. (2002) indicate. Thus teaching has become complicated due to the increasingly intricate phase of human personality and society. The idea is that a teacher must bear in mind certain principles of good teaching whiles dealing with the students.

According to Kochhar (2004) good teachers exhibit the following characteristics:

1. Recognize individual differences among people,
2. Create the learning situation,
3. Challenge the child to learn,
4. Encourage general development,
5. Cause, facilitate and promote learning.

It is clear from the above discussion that efficient or good teachers must have a sound knowledge of what their students must know and have the ability to relate the content, method, sequence and pace of work to individual needs; to use the environment and appropriate media to support learning, use a range of teaching strategies skilfully and have enthusiasm for the subject (Farrant, 1996). It is the teacher's duty and vital responsibility to motivate students in ascertaining their inner strengths and abilities and to discover what truly inspires them. The good teacher is therefore the one who has the willingness and passion to teach; respects and understands the individual learner, and creates learning situations that build up values in the individual learner for personal and societal satisfaction. It is vital therefore for the teachers to teach better in order to facilitate effective learning for the students (Siaw, 2009).

Good teaching has a key role of developing learning because within an education system, it is the most influential point that determines student outcomes. Good teaching influences the quality of student participation, involvement and achievement (including social outcomes). Clay (2001) clarifies that teaching is optimized when teachers have a good understanding of, and are responsive to the student learning processes involved. Such learning processes are, in general, specific to curriculum areas. Moreover, teaching is not a theoretical act that has universal application, but a very practical act that takes place in specific classrooms with unique students. Teachers may draw upon theories of instruction as inspiration in a diverse way but success in the classroom depends on the decision's teachers make based on their practical knowledge about teaching.

Alton-Lee (2003) explains that when teachers do not design their instructional programme to be responsive to the constraints of memory and knowledge generation, high achieving students can compensate to some extent through additional opportunities to learn at home. When this happens, low achieving students in particular and students from homes with lower cultural capital to match that of the school will fail to learn. It is therefore critical for teachers to understand the range of difficulties that low achievers may be encountering that inhibit knowledge construction.

2.2.2 Effective teaching

Effective teaching has been defined in many ways, and by different methods for measures (Goe & Bell, 2008). Although there is a general consensus that good teaching matters and that it may be the single most important school-based factor in improving student achievement, Goe and Bell (2008) indicate that teachers' roles involve much more than simply providing subject-matter instruction. Teacher effectiveness has therefore been defined under the following categories:

1. Effective teachers have high expectation for all students and help students to learn (Noel, 2006).
2. Effective teachers contribute to positive academic, attitudinal, and social outcomes for students such as regular attendance, on-time promotion, self-efficacy and cooperative behaviour (Millet, et al., 2007).
3. Effective teachers use diverse resources to plan and structure engaging learning opportunities, monitor students' progress formatively and adapt instruction as needed; and evaluate learning using multiple sources of evidence (Robert & Patt, 2007).

4. Effective teachers collaborate with other teachers, administrators, parents and education professionals to ensure students success, particularly the success of students with special needs and those with high risk of failure (Wright & Sanders, 2008).

The definitions cited here focus measurement efforts on multiple components of teacher effectiveness. The first point addresses students' achievement based on standardized test scores while the other points focus on teachers' contribution that may ultimately improve students' learning. However, because teachers impact students' learning and growth through the processes and practices, they employ, it is reasonable to state that an effective teacher can be described as the one who does what is likely to improve students' learning.

Education, according to UNESCO (2000), is a powerful agent which provides mental, physical, ideological and moral preparation to individuals, to enable them to have full consciousness of their task, of their purpose in life and to equip them to achieve that purpose. It is an instrument for the spiritual development as well as the material fulfilment of human beings. Education plays an important role in human resource development. It raises the productivity and efficiency of individuals and produces skilled manpower that is capable of leading the economic development. Notably, education is one of the most powerful instruments known for reducing poverty and inequality and for laying the basis for sustained economic growth. It is the fundamental instrument for the construction of a dynamic society. For individuals and for nations, education is the key to creating, applying, and spreading knowledge. Tuan (2009) opines that education encompasses both teaching and learning of knowledge, proper conduct and technical competency. He further defines education as the transfer of survivalist skills and advancement of culture from one generation to another. This means education is a process through which the intellectual and moral capacities of individuals are developed, so as to make them cultural members of their society. According to Mangal (2007), teaching and learning are the two fundamental aspects of the educational process. The most important objective of teaching is to facilitate learning. Thus, the concept of teaching is incomplete without learning. UNESCO (2000) asserts that teaching and learning forms the central part of education and provide both essential learning tools and the basic learning content required by human beings to be able to survive, to develop their full capacities, to live and work in dignity, to participate fully in development, to improve the quality of their lives, to make informed decisions, and to continue learning. For understanding constructivists approach to teaching and learning process, it is essential to study the nature of teaching and learning.

2.3 Learning and Learning Theories

In the process of education, learning occupies the central place. Whatever exists in the educational set-up is meant for learning by the learners (Forrester & Noel, 2009). Mangal (2007) defines learning as the process by which an activity originates or is changed through reacting to an encountered situation, provided that the characteristics of the change in activity cannot be explained on the basis of native response, tendencies, maturation, or temporary states of the organism such as fatigue from drugs. Learning can be termed as a process or its outcome in which necessary changes in the behaviour of the learner are brought about through experiences. Learning is a matter of developing competence and identity in relation to other members of a community of practice (Montgomery et al., 2005).

Mahar and Harford (2004, p.7) describe learning as "occurring most readily and effectively when whole brain processes is engaged, and in particular when the process of learning moves from experience to reflection on experience so that a pattern or framework allows the learner to grasp the meaning". Learning is understood as a set of cultural, social, and institutional processes that occur throughout an individual's life; that is life-long learning (Mahar & Harford, 2004). Learning in this sense occurs both within the education sector in early childhood centres, schools, tertiary and adult education institutions, and also a key element in the workplace where learning is an integrated activity that occurs both within and between people. Learning has thus been extended from the individual learner to the learning organization, and even to the 'learning society', which is a vital concept for the knowledge economy.

Learning is defined as a relatively permanent change in behaviour that occurs as a result of prior experience (Brown, Amuah, Anyage, Frimpong & Koomson, 2000). To Brown et al, learning is understood as the modification of behaviour through practice, training, or experience. This is supplemented with five important components of learning:

1. Learning involves change, but not all changes reflect learning.
2. Learning is reflected in behaviour, the change in behaviour should occur as a result of experience, practice or training and the practice or experience must be reinforced in order for learning to occur. Learning, according to Farrant (1996), is the process by which we acquire and retain attitudes, knowledge, understanding, skills and capabilities that cannot be attributed to inherited behaviour patterns or physical growth.

To Farrant, capacity for learning is innate and is based on psychological factors whiles rate of learning is based on both inherited and environmental factors. In contrast to this assertion, Skinner (as cited in Farrant, 1996) opines that learning is seen as a series of experiences, each of which influences behaviour. Learning results should therefore be considered in terms of understanding the core processes within the content standards. Farrant further explains that as much as the teacher's job is concerned, it is his duty to help the learner go through each of the learning stages in an efficient manner. Efficient learning therefore requires readiness, motivation and involvement on the part of the learner.

2.2.3 Forms of learning

Four forms of learning identified by Smith and Blake (2005) are formal, informal, incidental, problem based and situated learning. Formal learning follows a curriculum and a sequence of planned teaching and learning activities. Informal learning is not structured like the classroom situation but the learner sets out to learn something for himself. It is achieved through observation, discussion with others, asking questions, and even making mistakes and learning from them. Incidental learning happens as the result of other activity. In Situated learning, the knowledge acquired is used in the same situation in which it is gained. With Problem-based learning, activities are associated with solving a problem. The set problem can be in a formal setting in order to result in particular learning outcomes, or the learning may be achieved informally through working on a real life problem.

Dreyfus (as cited in Agbenatoe, 2011) proposes an influential five–stage model of expertise development. This model tells the stages through which a learner moves from being "empty vessels" to be filled with knowledge to become constructors of knowledge. These are "novice", "advanced beginner", "competent", "proficient", and "expert". People who are highly expert in a task move to what is known as „automaticity‟. This is where the task can be carried out automatically. This suggests that learning is supposed to progress learners (p. 15)

2.2.4 Learning styles

Giles, Pitre and Womack (2003) refer to learning styles as the uniqueness of how each learner receives and processes new information through their senses. The National Association of Secondary Principals of United States of America (as cited in Giles et al., 2003) defines learning styles as "the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment". Some of the other phrases used interchangeably with learning styles include perceptual styles, learning modalities, and learning preferences (Giles et al., 2003).

Giles et al. (2003) point out that each individual is born with certain preferences toward particular styles but culture, experience, and development influence these preferences. The four most common learning styles are visual, aural, reading-writing, and tactile. Most people learn through all modalities but have certain strengths and weakness in a specific modality. Some people have an equal propensity for more than one style, which is titled as the multimodal style. This preference can be determined through various testing instruments. Once a person's learning style is ascertained, accommodations can be made to increase academic achievement and creativity, as well as improve attitudes toward learning. The different learning styles are explained as follows;

1. The Visual (Spatial) Learning Style

The Visual learner processes information most effectively when information is seen. Depictions could include charts, graphs, flow charts, and all the symbolic arrows, circles, hierarchies and other devices that instructors use to represent what could have been presented in words. These learners think in pictures and have vivid imaginations. Most people are classified as visual learners. A visual learner's suggestions focus on the use of visual aids to increase information processing (Giles et al., 2003).

Learning strategies for Visual Learning style

Giles et al. (2003) indicate that to help visual learners‟ teachers need to:

6. Replace words with symbols or initials
7. Translate concepts into pictures and diagrams.
8. Underline or highlight notes or textbooks with different colours.
9. Practise turning visuals back into words.
10. Make flashcards of key information with words, symbols and diagrams.

2. The aural learning style

In the view of Giles et al. (2003), aural learners process information most effectively when the information is spoken or heard. These learners respond well to lectures and discussions and are excellent listeners. They also like to talk and enjoy music and dramas. When trying to recall information, aural learners can often "hear" the way someone told them the information. An aural learner needs to discuss the new improvement that point to the benefits of obtaining information in an oral language format.

Learning Strategies for Aural Learning Style

11. Attend lectures and tutorials.
12. Discuss topics with instructor and other students.
13. Put summarised notes on tape and listen to them.
14. Join a study group or have a "study buddy".
15. Tape or record lectures.
16. Talk aloud when recalling information or solving problems

3. The reading-writing learning style

Reading-Writing learners process information very efficiently when presented in a written language format. This type of learner benefits greatly from instructors who use the blackboard to highlight salient points or provide outlines of the lecture material. When trying to recall information, reading/writing learner finds training manuals very comprehensive if they are put into written language format (Giles et al., 2003).

Learning Strategies for Reading-Writing Learning Style

17. Write out important information again.
18. Read notes silently.
19. Organise any diagrams into statements.
20. Rewrite the ideas and principles in other words.
21. Make flashcards of words and concepts that need to be memorised.

4. The Kinaesthetic-tactile learning style

Giles et al. (2003) explain that kinaesthetic-tactile learner processes information actively through physical means. Kinaesthetic learning refers to whole body movement while tactile leaning refers only to the sense of touch. These learners gesticulate when speaking, are poor listeners, and lose interest in long speeches. Most students who do not perform well in school may be Kinaesthetic-tactile learners, if teaching methods are devoid of practical activities. The crux of this learning style is that the learner is connected to real situations through experience, example, practice, or simulation. A Kinaesthetic-tactile learner does well in "hands on" demonstrations and field experiences.

Learning Strategies for Kinaesthetic-tactile Learning Style

22. Sit near the instructor in classroom situations.
23. Read aloud from textbooks and notes.
24. Copy key points onto large writing surface such as chalkboard or easel board.
25. Copy key points using word processing software.
26. Listen to audiotapes of notes while exercising.
27. Take in information through field trips, laboratories, trial and error, exhibits, collections, and hands-on examples.
28. Put real life examples into notes summary.
29. Recall experiments and role-play.

5. Educational implications of learning styles

According to Giles et al. (2003), a teacher who uses the ideas of learning styles exposes their students to many approaches to intellectual exercise. The activities planned by these teachers are more students-centred than traditional activities. Three steps have been pointed out in implementing learning styles in education. The first step is to diagnose the preferred learning style of the students. Secondly, the teacher has to outline the group preferences and weaknesses. For instance, are most students visual learners? Finally, assess the current instructional methods to determine whether they are adequate or require more flexibility. Giles et al. (2003) conclude that when teaching an individual, teachers should present the most difficult concepts in a style preferred by the learner. Easier concepts should be introduced in a different style. When teaching an entire class, teachers should use all learning styles in their presentation if they are to reach every student.

A pupil who is highly motivated to learn and sees its usefulness can make better progress than one who has a lower degree of aspirations, interest and motivation. If one is motivated to learn, he/she appreciates its value and chances to perform in it are too high (KESSP, 2006). Motivation also can play a factor in poor performance. A student may be fully capable of earning high grades but might simply not care enough about education to exert the effort. Issues of motivation could be placed upon the parents or even the school, but sometimes a child simply does not enjoy learning. The weakness of enthusiasm, lack of experience and hasty in getting the results are considered causes that often lead to academic failure, along with lack of abilities, fear of failure and lack of self-confidence. Therefore, academic failure occurs when someone convinces himself/herself that he/she is unable to succeed because of the weakness of his/her abilities and lack of experience. The goals should also be clear, specific and realistic to the learner. Failure to do so will result in missing these goals**.**

Wilkins (1987) asserts that when a class consists of voluntary learners a certain degree of self-motivation can be taken for granted and exploited, but when learners are not volunteers, the teacher must stimulate and retain the motivation. The same view is expressed by Mokono (2004) not much was happening to change the negative attitudes of pupils towards learning despite there being set school policies. Learners' attitudes toward learning grow increasingly negative as they progress through school (Majoribirik, 2000). According to Etsey (2000) the pupils' characteristics found to have significant correlation with pupils' poor performance were: absenteeism and regularity in school, truancy, use of local language in the classroom, lack of interest and joy in the teachers lessons and little help with studies at home. Tschinke (1998) also argued that most of the differences in school performance are associated with characteristics student bodies and not with characteristics of schools.

Attendance is identified by some researches to contribute to academic performance. A study revealed in Delta State, Nigeria by Oghuvbuin (2010) that, there is a fairly positive relationship between attendance and academic performance of students in secondary schools in Delta State.

Exam's anxiety and exam Phobia among students also causes poor academic performance. Exam's anxiety is a state of feeling or an emotional condition that student faces during the exam, and arise from the fear of failing in the exam or the fear of not getting satisfactory result for himself and for others. However, this emotional state may affect mental processes such as paying attention, concentrating, thinking and remembering, as a result of the fact that any examination or test may decide the fate of its taker and it will affect a particular aspect of his life, such as success in the study, admission to a particular job and others, causing him fear and not achieving the requested level. Exam phobia is a case of a sever fear of the exam and the expectation of failure, which weakens the educational achievement and preparation and is accompanied with less attentive and not fully prepared for the exam.

The notion of learning as a social process is becoming accepted amongst educational researchers, policy makers and practitioners. Properly applied, it should enhance learning for all individuals as they negotiate their way through life. In line with the understanding of what learning means, the following subsection sought to discuss some learning theories.

Theorists use different terms to explain how people learn, and deductions of different perspectives are generated to provide a more holistic view of learning (Freiberg, 2000). According to Chen (2006), there are three main viewpoints of learning theories: behaviourist, cognitive and constructivist.

2.3.1.1 Behaviourist perspective of learning

The behaviourists' perspective, according to Haberkorn (2010), view learning as a change in behaviour and the purpose of learning is to produce a behavioural change in a desired direction. The theory also considers learning as the modification of behaviour brought about by experience (James, 2006). In this theory, it is accepted that learning takes place in a learning environment and under certain conditions. Behaviourism concerns itself solely with measurable and observable data and excludes explicit ideas, emotions, and the consideration of inner mental experiences and activities and is not interested in conscious (cognitive) control processes (Dietinger, 2003).

The theory focuses on strengthening the stimulus-response association (Hayford, 2007) which means by using positive or negative reinforcements, instructors can gradually shape learners' behaviour (James, 2006). Behaviourism emphasizes the importance of practicing learning tasks repetitively and therefore interprets learning in terms of observable change in behaviour (Morris & Maisto, 2001). It implies that behaviours are learned in the process. In this theory, the learners observe the information, practice the information and then receive reinforcement through praise (Papalia, Olds & Feldman, 2007).

According to James (2006), behaviourists consider the environment for learning to be the determining factor and learning as the conditioned response to the external stimuli. They consider rewards and punishments, or at least the withholding of rewards, as powerful ways of forming or extinguishing habits. Praise may be part of such a reward system. This theory also takes the view that complex wholes are assembled out of parts, so learning can best be accomplished when complex performances are deconstructed and when each element is practiced, reinforced and subsequently built upon. The teacher's role is therefore to arrange the environment to elicit the desired responses and assess this to ascertain whether all students have achieved the desired responses. The learning tasks are designed to be reliable and challenging to motivate students. Multiple viewpoints are encouraged, and students can discuss and debate their opinions.

Steele (2005) states that the application of the behaviourist theory in the classroom is usually considered as explicit or direct instruction. Although this approach has been criticized within general education, it had shown promising research results, particularly for children with learning problems. Many aspects of general and special education such as curriculum, pedagogy and assessment have been shaped by the principles of behaviourist learning theory.

2.4 The Principles and Strategies of Constructivist

Teaching Constructivist teaching stands in contrast to traditional teaching practice in the Korean classroom. Traditionally, learning has been thought to be nothing but a repetitive activity, a process that involves students imitating newly provided information in tests. The constructivist teaching practice, on the other hands, helps learners to internalize and transform new information. Transformation of information occurs through the creation of new understanding that results from the emergence of new cognitive structures. Teachers may invite transformations but may neither mandate nor prevent them. Deep understanding is, unlike the repetition of prescribed behaviour, the act of transforming ideas into broader, more comprehensive images which escape concise description. The principles of constructivist teaching are: 1) posing problems of emerging relevance to students; 2) structuring learning around primary concepts: the quest for essence; 3) seeking and valuing student's points of view; 4) adapting the curriculum to address students' suppositions; and 5) assessing student learning in the context of teaching (Brook & Brooks, 1993)

Traditional instruction leads students to believe they are not interested in particular subject areas. The constructivist paradigm holds disinterest less as a function of a particular subject area than as a function of the ways in which students have been taught. Let's look at the following table, which summarizes the differences in school environment between traditional classrooms and constructivist classrooms: Some characteristics of constructivists teaching are: 1) constructivist teachers invite student questions and ideas. 2) Constructivist teachers accept and encourage students' invented ideas. 3) Constructivist teachers encourage student's leadership, cooperation, seeking information, and the presentation of the ideas, 4) constructivist teachers modify their instructional strategies in the process of teaching based upon students; thought, experience and or interests. 5) Constructivist teachers use printed materials as well as experts to get more information. 6) Constructivist teachers encourage free discussions by way of new ideas inviting student questions and answers. 7) Constructivist teachers encourage or invite students' predictions of the causes and effects in relation to particular cases and events. 8) Constructivist teachers help students to test their own ideas. 9) Constructivist teachers invite students' ideas, before the student is presented with the ideas and instructional materials. 10) Constructivist teachers encourage students to challenge the concepts and ideas of others. 11) Constructivist teachers use cooperative teaching strategies through student interactions and respect, sharing ideas and learning tasks. 12) Constructivist teachers encourage students to respect and use other people's ideas through reflection and analysis. 13) Constructivist teachers welcome the restructuring of his/her ideas through reflecting on new evidence and experiences (Yager, 1991) The instructional strategy of constructivist teaching is inviting ideas, exploring, proposing explanations and solution, and taking action (Yager, 1991).

2.4.1 The cognitive perspective of learning

Cognitive learning theorists view learning as a process of understanding and internalizing aspects of the world around us. The theory views knowledge as personal interpretation of experiences that learners encounter. This means learners build or change their internal knowledge structures based on prior experiences, and the knowledge structures serve as the foundation for acquiring new knowledge.

According to Brown (2004), cognitive psychologists view learning as the study of how information is sensed, stored, elaborated and retrieved. According to Eggen and Kauchak (2007), learning is a change that occurs in the learner's mental behaviour. It means that the theory focuses on keeping the learner's attention. Reinforcement is used primarily as feedback (Woolfolk, 2004). Cognitive theorists emphasize the importance of understanding learners' existing conceptions and misconceptions, so that teachers can help them process new information or correct misconceptions. Cognitive learning theory therefore views learning as a process of understanding and internalizing aspects of the world around us.

Moreover, James (2006) observes that the cognitivist theory is complex and differentiated and it is difficult. Nonetheless, the role of the teacher is to help novices to acquire expert understanding of conceptual structures and processing strategies to solve problems by symbolic manipulation with fewer searches. However, it will be viewed that when a new situation is far beyond the interpretation of an individual because the cognitive structures are not at an appropriate level, the individual may either ignore or distort the new information.

According to James (2006), this theory is interested in how people construct meaning and make sense of the world through coordinating structures, concepts and principles in schema (mental models). Prior knowledge is regarded as a powerful determinant of a pupil's capacity to learn new material. In terms of school activities, the theory emphasizes the procedures by which students actively interpret the interaction and coordinate internal structures while participating in activities. This implies that learning occurs personally and internally, the teacher and the students only have to coordinate their individual activities with each other.

2.4.2 The constructivist perspective of learning

According to constructivism, learning is a process of knowledge construction occurring within learners (Chen, 2006). The theory argues that learners actively construct frameworks of understanding (cognitive schema) by using both the knowledge they already possess, and new information that is presented to them. It describes learning due to the construction of knowledge and focuses on the understanding of the information. Constructivist theory of learning focuses on socialization. The argument is that learning is primarily concerned with how people develop different conceptions and constructions of reality (Hayford, 2007). The learners are presented with guiding questions and they study together to develop new information (Morris & Maisto, 2001).

Learning is considered as a reconstruction rather than a transmission of knowledge which means learners assimilate new information and modify their understanding in the light of new data (Dietinger, 2003). In constructivism, learners actively construct their understanding based on their prior experiences and existing knowledge structures (Chen, 2006). Through interacting with the environment, tools, and other people, learners gradually apprehend the shared knowledge, language, and culture (Wells, 2000). In constructivist education, the teacher designs learning activities to engage students in active problem solving and genuine inquiry. With reference to the learner, learning conditions are both external and internal. These conditions are in turn dependent upon what is being learned (Forrester & Jantzie, 2011).

For effective learning, the constructivist theory says prior ideas must be engaged and re-worked as new information come along. Lambert and Lines (2000) add that the constructivist learning is an interactive process therefore quality of teaching and learning depends on communication based on mutual understanding.

Suggestions for Teaching with the Constructivist Learning Theory;

- Encourage and accept student autonomy and initiative (Steele, 2005).
- Try to use raw data and primary sources, in addition to manipulative, interactive, and physical materials (Feldman, 2005).
- Search out students' understanding and prior experiences about a concept before teaching it to them (Papalia, Olds, & Feldman, 2007).
- Encourage communication between the teacher and the students and also between the students (Santrock, 2008).

- Provide enough time for students to construct their own meaning when learning something new (Santrock, 2008).

Grounded in the objective of the study, the researcher would focus on only the constructivists approach to teaching and learning among students.

Table 2.1: A look at the school environment

Traditional Classrooms	Constructivist Classroom
Curriculum is presented part to whole, with emphasis on basic skills.	Curriculum is presented whole to part with emphasis on big concepts
Strict adherence to fixed curriculum is highly valued	Pursuit of student questioning is highly valued
Curricular activities rely heavily on textbooks and workbooks	Curricular activities rely heavily on primary sources of data and manipulative materials
Students are viewed as "blank slates" onto which information is etched by the teacher	Students are viewed as thinkers with emerging theories about the world
Teachers generally behave in a didactic manner, disseminating information to students	Teachers generally behave in an interactive manner, mediating the environment for students
Teacher seeks the correct answer to validate student learning	Teachers seek the student's point of view in order to understand student's present conceptions for use in subsequent lessons
Assessment of student learning is viewed as separate from teaching and occurs almost entirely through testing	Assessment of student learning is interwoven with teaching and occurs through teacher observations of students at work and through student exhibitions and portfolios
Students primarily work alone	Students primarily work in group

Source: Cited from Brooks and Brooks, 1993, p.17.

2.5 Constructivist and Theories

Constructivist ideas in pedagogy have evolved since the 17th century, based on the philosophers of that time, who believed that a person can understand only what he had constructed himself. The idea of constructivism is based on the fact that the human brain does not directly reflect the external world, but constructs its experience and life in cognitive and emotional processes in the social context as subjective ideas and concepts.

A number of theories may be used as a basis to underpin the constructivist approach. However, the researcher focused on three theories which include sociocultural theory, identity construction theory, and critical argument theory.

2.5.1 Sociocultural theory

Sociocultural theory as Lantolf and Thorne (2006) point out, clearly connects socio interactional constructivist theory with a collaborative learning environment such students in the senior high schools. Through the incorporation of sociocultural conventions of academic discourse, it allows for the students' and teachers' social and cultural backgrounds and positionalities to inform a concept analysis in valuable ways, and to recognize the significance this has on senior high students engaging critical thinking skills in establishing identity and developing critical argument in learning mathematics.

In a constructivist approach, the focus is on the sociocultural conventions of academic discourse such as citing evidence, hedging and boosting claims, interpreting the literature to back one's own claims, and addressing counter claims. These conventions are inherent to a constructivist approach as they place value on the communicative, interpersonal nature of learning. For example, in this study, both student and instructors will base their understanding of the concept on the societal experiences

2.5.2 Identity construction theory

This theory involves the formation of both cultural identity and academic identity. In cultural identity construction, social interaction is the basis for people's understanding of their position in relation to others within the same cultural community. Identity construction theory helps in explaining the ideational and interpersonal relationships involved in forming an academic identity. Ivanić (2004) as cited in McKinley (2015) built on this theory to explain that the construction of academic identities is dependent on social and cultural factors and is developed in discourse when a student makes particular language choices in attempts to understand a concept.

Constructivist learning has significant implications for the construction of cultural identity in that, for adult learners with many years of experience and accumulated diagrams, new information must be connected to neurological structures already in existence. Cultural identity building is an ongoing process that is affected by various social, cultural and historical factors that are especially realized in education settings, as illustrated by Gomez et. al, (2011, p. 231): Cultural identity is not an immutable "essence" placed in the heart of our mind, but a malleable process that is constructed in relation to the social settings (such as formal education) in which people participate. The fact that the process in the construction of cultural identity it participatory allows learners to take individual ownership of that construction. In their examination of social constructivist theory, Stetsenko and Arievitch (1997) argue that, "constructing the self and deconstructing it can be viewed as the two alternative strategies ensuing from the socio constructivist approach". the first being discourse-based, which sees the self in the social reality of discourse; and the second a post-Vygotskian perspective, which sees a guided formation of the self. These two perspectives do not suggest that an individual is self-contained, but rather offer "a relational, contextualized account of the evolving self". Thus, in this study, the students would attempt the approach base on the understanding of their position in relation to others within the same cultural community.

2.5.3 Critical argument theory

The critical argument theory maintains that an argument generates a discussion in the shared construction of knowledge (Eemeren & Grootendorst, 1992). As it pertains mathematics, the theory builds on the idea that students use different ways and forms of developing an argument. Different ways might be taking a stance first based on one's own diagrams and later supporting it with source evidence, or reading widely first and deciding on a stance based on the evidence. Different forms might include deductive or inductive approach (Clark & Ivanic, 1997). In the development of critical argument, student must exercise critical thinking skills. This is done in the reception of instruction in the classroom, and in the expression and development of the concept.

2.6 Definitions and Classifications of Quadrilaterals

Poincaré (1952), a well known French mathematician, explained the close relationship between definitions and classification with the following words: The aim of each part of the statement of a definition is to distinguish the object to be defined from a class of other neighbouring objects. The definition will not be understood until you have shown not only the object defined, but the neighbouring objects from which it has to be distinguished, until you have made it possible to grasp the difference, and have added explicitly your reason for saying this or that in stating the definition. (p. 133). It can be inferred from this statement that the definition and classification are intertwined issues in the sense that the properties used to define a concept allow us to include the concept into a class of objects which have these properties and the reason of defining a concept is to determine its place among the other concepts. Therefore, this statement of Poincaré paved the way for several researchers to study the definitions and the classification as intertwined issues in the field of geometry. Furthermore, literature also revealed that several researchers found the concept of quadrilaterals to be the best subject to study the intertwined concept of definitions and classification. First of all quadrilaterals are popular because of their having been experienced both theoretically and educationally since the time of Euclid and they still keep this popularity due to the problems that could not be overcome so far (Furinghetti & Paola, 2002).

Moreover, the topic quadrilaterals provide a rich world of shapes to investigate the notion of equivalent definitions and the hierarchical or partition classifications through both verbalization or visualization processes (Furinghetti & Paola, 2002). For the studies that investigate the definition and classification notions in the dynamic geometry environment to underline the cognitive character of the dynamic geometry tools and for the studies that investigate learners' geometrical reasoning ability in the concept of definitions on the bases of van Hiele reasoning levels, studying with the family of quadrilaterals is found to be the best appeal to obtain rich data (Furinghetti & Paola, 2002; Jones, 2000). From other point of view, there is a need for conducting further studies in the quadrilaterals topic even though it has been studied since the time of Euclid; because due to the complex nature of quadrilaterals there are still unsolved learner difficulties and there are some disagreements on some quadrilateral related issues such as classification of quadrilaterals in the literature (Jones, 2000; Wu & Ma, 2005). Therefore, several researchers studied the close relationship between definition and classification issues in the concept of quadrilaterals (e.g., Athanasopoulou, 2008; Cannizzaro & Menghini, 2006; Fujita & Jones, 2007; Usiskin & Griffin, 2008). Having analysed the different types of classifications throughout the history, Athanasopoulou (2008) came up with those different definitions of quadrilaterals and corresponding different lines of reasoning led to different types of classification throughout the history. De Villiers (1994) also articulated that the process of defining and classification are depended to each other, and they are not isolated processes and differentiated between different types of classification. He defined hierarchical classification as "the classification of a set of concepts in such a manner that the more particular concepts form subsets of the more general concepts" (p. 11).

On the other hand, he defined partition classification as the classification where "the various subsets of concepts are considered to be disjoint from one another" (p. 11). He stated that both of these classifications and their corresponding definitions are accepted and employed equally in different fields of mathematics; in other words, none of the classifications are incorrect. Emphasizing the arbitrariness of definitions and so the corresponding classifications, De Villiers (1994) stated that using whether partition or hierarchical definitions and classifications depends on the personal purposes and preferences; however, he explained that he was in favour of hierarchical classification owing to the important functions of this type of classification. According to him, considering the hierarchical relationships provides a more general conceptual schema which makes it easier to deduce the properties of the more special concepts through the more general concepts and to construct different alternative definitions including the minimal properties generalizing a class of concepts.

Fujita and Jones (2007) also agreed with De Villiers (1994) on the economic function of hierarchical classification stating that a true statement for a concept in this type of classification will also be true for all specific subsets of the concept. Another reason of hierarchical classification's being more functional is that understanding a hierarchical relation improves the ability to realize the different classification ways for the same concept and ability to understand the transitivity, asymmetry, and opposite asymmetry of relations among the shapes (Fujita & Jones, 2007). For instance, understanding class inclusions between concepts requires the ability to define the concept differently in terms of other more general concepts; to make transitive reasoning such as if a square is a rectangle and a rectangle is an isosceles trapezoid then a square is an isosceles trapezoid; to understand lack of symmetry within the relations like a square is a rectangle but a rectangle is not a square; to understand the opposite inclusive relationship (Schwarz & Hershkowitz, 1999) between the concepts and their properties such as a square is a rectangle a rectangle is not a square; but while all properties of a rectangle are valid for a square, all properties of a square are not valid for a rectangle. Therefore, classifying objects is an important mathematical ability which is the result of students' better understanding the similarities and differences and inclusive relations between concepts and it helps learners to have better control over the concepts that are classified (Welter, 2001). However, complex nature of the relationships between the concepts makes it difficult for learners to understand the inclusive definitions and corresponding hierarchical classifications (Fujita & Jones, 2007; Schwarz & Hershkowitz, 1999). In a very recent monograph devoted to the definition and classification of quadrilaterals, Usiskin and Griffin (2008) analysed several textbooks from the year 1838 up to the present in order to identify the change in definitions through the years and they found several equivalent definitions for each quadrilateral, except for trapezoid. As a result of their analysis, they concluded that the disagreement in the literature about the definition of trapezoid gave rise to the disagreement in the ways in which quadrilaterals are classified and related to each other.

Usiskin and Griffin (2008) explained that when "one definition purposely excludes what the other definition includes, we call the one definition an exclusive definition and the other definition an inclusive definition" (p. 4). For example, if a trapezoid is defined exclusively as "a quadrilateral with exactly one pair of parallel sides" (p. 27), then parallelograms and trapezoids would be identified as disjoint subgroups of quadrilaterals. However, if the trapezoid is defined inclusively as "a quadrilateral with at least one pair of parallel sides" (p. 27), then all parallelograms would be a subgroup of trapezoids and trapezoids would include the parallelograms. Therefore, as explained by Usiskin and Griffin (2008), while an inclusive definition leads to a hierarchical chain, an exclusive definition leads to a partition chain. Similar to the De Villiers (1994), Usiskin and Griffin (2008) also distinguished between the two types of classifications on the basis of the choice of inclusive or exclusive definitions. They explained hierarchical classification as the classification based on the inclusive definition of quadrilaterals and explained partition classification as the classification based on the exclusive definition of quadrilaterals. Examining the several geometry textbooks, researchers came up with that those books published before the 1930's were bounded by the exclusive definitions being influenced by the Euclidean definitions (Usiskin & Griffin, 2008).

2.7 Related Studies on Constructivists approach to Teaching and Learning of Mathematics

Few literatures support the study of contrastive approach for the teaching and learning of mathematics concepts. Laz and Shafer (2014) studied the effectiveness of constructivist learning model in the teaching of mathematics in Saudi Arabia primary data from a sample of students in the preparatory year at the University of Tabuk and the two divisions to choose at random to represent one of the experimental groups and the other control group. A sample of students of 44 and 47 students respectively were selected from each class. The study revealed that there were statistically significant differences between the mean scores of students of experimental and control groups in the post application to test the statistical concepts for the benefit of students of the experimental group. Anyanechi (1998) investigated the use of a constructivist model to teach science to senior secondary school students in Nigeria (Anyanechi, 1998).

A total of 70 participants were used for the study who were equally divided into two treatment groups: Group A and Group B. The study used local materials from the students'' environment with qualitative/ethnographic research methods, content analysis was performed on the two groups of students, Group A and Group B, who used different teaching methodologies. Group A used a constructivist model; Group B used a traditional model. The study concluded that, the constructivist model created a better and broader experiencing environment and understanding. The study further revealed that. The use of local materials and the teaching methods were essential tools to reactivate Group A''s prior knowledge and for the experiences. Abbot et. al, (2003) built their study on 2001-02 classroom observation study of Washington K-12 and technical schools that identified the extent of constructivist teaching activity. Results from classroom observations found that strong constructivist teaching was observable in 17 percent of the classroom lessons. The other 83 percent of the lessons observed may have contained some elements of constructivist teaching, but up to one-half had very little or no elements of constructivist teaching present. More constructivist teaching appeared to occur in alternative schools and integrated subject matter classes. The study further went ahead to explore the relationship of this practice to student achievement, examining the percent of variance in student achievement accounted for by constructivist teaching beyond that contributed by low-income. Data came from the original observation study and from school-level standardized test scores of 4th, 7th, and 10th graders. The study revealed large correlations between study variables (a negative correlation between school-level family income and student achievement, large positive correlations between constructivist teaching and student achievement, and a negative correlation between constructivist teaching and school-level family income).

Assuah et al. (2016) explored Ghanaian primary school mathematics teachers' ideas, beliefs and practices of constructivist instructional strategies (CIS). The study used a sequential exploratory design, comprising two hundred and fifty-two (252) mathematics teachers comprising of 126 lower primary teachers and 126 upper primary teachers, who were purposively selected from school districts in the Upper East region. A mixed method of both qualitative and quantitative method was used in this study. The qualitative data consisted of interview responses and lesson observations. The quantitative data consisting mainly of teachers' responses to a 3-point Likert scale questionnaire items. The results indicated that through CIS pupils were able to construct their own understanding, and were willing to follow learner-centred method of instruction. Additionally, teachers became aware of social interaction and authentic learning tasks, two aspects of CIS. The study also revealed that as teachers' perceptions of CIS increased, their frequency of use of selected CIS correspondingly increased. The researcher therefore concluded that mathematics teachers should be provided with resources that would enable them teach using CIS.

All the previous study mentioned above relied on mixed method approach to their study and all the study group participants in groups to assess the difference in their results. However, all the studies were done on a broad scope. They didn't focus on a concept under mathematics or science. In addition, most of the studies were done outside Ghana. This current study therefore focused on the application of the constructivist approach to just an aspect of mathematics which is geometry.

2.8 Teaching and Learning of Geometry

According to Fidan (1986), the requirement to divide a piece of surface properly gave birth to geometry which is the information of measurement of objects and shapes and expression by the numbers. That's why this course has direct place in people's daily lives. The first inspiration sources of the mathematics phenomenon are the nature and the life. It is more required and easier to relate its geometrical side of this phenomenon. What people have done on behalf of geometry is to see the existing and undeniable truths in the nature and to take these relations to the new truths and new relations by discovering the relations among them (Develi & Orbay, 2003). People make decisions in their works and jobs by depending on their information regarding geometric shapes and objects. Many artefacts make use of geometry in the works for example, the carpenter measures angles for house buildings, engineers decide on which angles to slope when constructing a road, gardeners plan the geographical formations and positions on which flowers are grown etc. (MEB, 1991).

Hoyo (2004) posit that, students' performance in solving geometry task is very low as compared to other areas in mathematics curriculum such as algebra or arithmetic. He further posited that; it is likely that the classroom teachers leave geometry subject matter to be taught at the end of the school period. This means that some teachers gloss over some aspects of geometry or do not teach it at all and as a result create learning gaps. Jones (2000) asserts that the successful teaching of geometry is premise on the teachers knowing a good deal of geometry and how to teach it effectively. He further suggested that attention could be usefully being paid to both the initial and continuing education of mathematics teachers in terms of their background and understanding of geometry.

Mathematics is made up of branches including arithmetic's, geometry, algebra, trigonometry, calculus etc. according to (Kamilombilo & Sakala, 2015). However, geometry provides a rich source of visualization for understanding algebraic arithmetic and statistical concepts. Geometry, the branch of mathematics concerned with the shape of individual objects, spatial relationships among various objects, positions angles, dimensions of things and the properties of surrounding space. Flat shapes like squares, circles, and triangles are a part of flat geometry and are called 2D shapes. It is one of the oldest branches of mathematics, having arisen in response to such practical problems as those found in surveying, and its name is derived from Greek words meaning “Earth measurement.” Eventually, it was realized that geometry need not be limited to the study of flat surfaces (plane geometry) and rigid three-dimensional objects (solid geometry) but that even the most abstract thoughts and images might be represented and developed in geometric terms.

The following items can be among some reasons why geometry is given place in mathematics teaching at schools (Baykul, 2005).

1. Critical thinking and problem solving occupy an important role amongst mathematical studies at school. Geometry studies provide significant contribution to the skills of critical thinking and problem solving.
2. Geometry subjects give assistance in teaching other topics of the mathematics. For instance, geometry is utilized to gain the concepts regarding fraction and decimal numbers; rectangles, squares, areas and circles are mainly used to teach the techniques of the operations.
3. Geometry is one of the most important parts of the mathematics which is used in daily life. For example, the shapes of the rooms, buildings and shapes used for ornaments are geometric shapes
4. Geometry is a device which is used a lot in science and art as well. As an illustration, it can be said that architects and engineers use geometric shapes a lot; geometrical characteristics are used quite much in the physics and chemistry.
5. Geometry helps students gain much more awareness about the world in which they live and appreciate its value. For example, the shapes of crystals and the orbits of the space objects are geometric.
6. Geometry is a tool that will help students have fun and even make them love mathematics. For example, they can have enjoyable games with geometrical shapes through cutting, pasting, rotating, parallel displacement and symmetry. It is required that a person who will be in charge of teaching and training of students must have comprehensive knowledge of the subject and must know the growth and development of human closely. Geometry is one of the

primary courses which are difficult to learn and comprehend for students. It is a fact that the success level in geometry is low. As a result of this, mathematics and geometry is a nightmare for most of the students (Akın and Cancan, 2007), because mathematics is a system on its own. One of the reasons lying beneath this failure is that geometrical thinking skills of the students are lower than expected. Thus, different teaching methods must be applied to be able to improve these skills and to make the teaching much more efficient. Within this context, geometry needs a strong pedagogical approach besides deep knowledge to be able to provide an enjoyable and intellectual atmosphere for students. The role of teacher is to guide students to have a better and comfortable thinking rather than to force students to think in his/her own limits because in today's pedagogical view, knowing much or having deep knowledge of any subject is not of high importance; the way how teachers present or guide to get the information occupies more significance. Hence, according to new teaching approaches, it is required for teachers to try to understand the codes and perceptions of any students rather than expecting students to understand what is hidden in teacher's mind.

2.9 Problem with the Teaching and Learning of Geometry

Learning geometry at the Junior High School (JHS) level is not easy and many of them fail to develop an adequate understanding of geometry concepts, geometric reasoning and geometric problem-solving skills (Battista & Clement, 1995; Mitchelmore, 2002). Without a good foundation in geometry at the JHS level this problem may worsen at the Senior High School level where students may face difficulty in mastering more complex geometry concepts such as transformation and trigonometry.

According to Strutchens et al. (2001), students learn geometry by memorizing geometric properties rather than by exploring and discovering the underlying properties. Geometry knowledge learned in this way is limited and superficial. For example, if students memorize that a square has four equal sides, they are unable to distinguish between a square and a rhombus. Eventually these students will find difficulty in applying that limited geometry knowledge in problem solving. This lack of understanding often discourages the students, invariably leading to poor performance in questions involving geometry. A number of factors have been proposed to explain what makes geometry learning difficult. First, the geometry language, which involves specific terminology, is unique and needs particular attention and understanding before it can be used meaningfully.

Next, geometry requires visualizing abilities but many students cannot visualize three dimensional objects in a two-dimensional perspective. Visualizing cross-sections of solids is very difficult for students lacking ample prior concrete experiences with solid objects. Due to their limited geometric experiences, students may not have enough opportunities to develop and exercise their spatial thinking skills for effective geometry learning. Another problem is that traditional approaches of geometry instruction do not seem to help students achieve the intended learning outcomes in the curriculum. By using just textbooks and chalkboards, classroom geometry experiences hamper optimal learning. In the Ghanaian context, this concern is shown in the poor geometry performance of students in public examinations (WAEC Report, 2003 - 2012). There is an urgent need to change the traditional mode of geometry instruction to one that was more rewarding for both teachers and students. Specifically, learners must be given opportunities to personally investigate and discover geometry to enable understanding of the subject in depth and also in relation to the other fields of mathematics. In addition, Kor (1995) did a study on the need assessment on the Van Hiele levels of the geometric content of two Malaysian Mathematics textbooks. She observed that from the chapter on quadrilaterals in the Form 2 mathematics textbook that, the definitions of quadrilaterals were tabled for easy memorization. However, nowhere could she identify that students had any opportunity to explore attributes of quadrilaterals or develop spatial thinking and geometry problem solving skills. Consequently, a diagnostic test revealed problems students encountered with angle estimation, angle-drawing, concept definition, and classification (Kor, 1995).

2.9.1 Implementation of school mathematics in Ghana

The study of geometry contributes to helping students develop the skills of visualization, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument and proof. Geometric representations can be used to help students make sense of other areas of mathematics: fractions and multiplication in arithmetic, the relationships between the graphs of functions (of both two and three variables) and graphical representations of data in statistics. Spatial reasoning is important in other curriculum areas as well as mathematics: science, geography, art, design and technology. Working with practical equipment can also help develop fine motor skills (Haggarty, 2002). Geometry provides a culturally and historically rich context within which to do mathematics. There are many interesting, sometimes surprising or counter-intuitive results in geometry that can stimulate students to want to know more and to understand some of the results in geometry. Presenting geometry in a way that stimulates curiosity and encourages exploration can enhance students learning and their attitudes towards mathematics. The contribution of mathematics to students spiritual, moral, social and cultural development can be effectively realized through geometry. Geometry is a rich source of opportunities for developing notions of proof. It is worth emphasizing that visual images, particularly those that can be manipulated on the computer screen, invite students to observe and conjecture generalizations. To prove conjectures, Ghanaian students need to understand how the observed images are related to one another and are linked to fundamental 'building blocks' (Haggarty, 2002).

Again, we live on a solid planet in a three-dimensional world and, as much of our experience is through visual stimulus, this means that the ability to interpret visual information is fundamental to human existence (Haggarty, 2002). To develop an understanding of how spatial phenomena are related to and apply that understanding with confidence to solve problems and make sense of novel situations has to be part of the educational experience of all students. Geometry offers a rich way of developing visualization skills. Visualization allows students a way of exploring mathematical and other problems without the need to produce accurate diagrams or use symbolic representations. Manipulating images in the head can inspire confidence and develop intuitive understanding of spatial situations. Sharing personal visual images can help to develop communication skills as well as enabling students to see that there are often many ways of interpreting an image or a written or spoken description (Haggarty, 2002). In addition, in Ghana much of our cultural life is visual. Aesthetic appreciation of art, architecture, music and many artifacts involve geometric principles – symmetry, perspective, scale, orientation, and so on. Understanding many scientific principles and technological phenomena also requires geometric awareness, as do navigation, orienteering and map-reading. Recognition of the familiar and the unfamiliar requires an ability to characterize and note key features.

2.10 Influence of Educational Developments in the Teaching and Learning of Geometry

The changes in mathematics curriculum which brought the changes in name to "Modern mathematics" imported from the English curriculum but was not properly adopted brought changes to the way mathematics was taught in Ghana. The change was to enable children to learn basic language and structure of mathematics as early as possible. The major aim of the modern mathematics was to link school mathematics to university mathematics (Mereku, 2004). In 1967 the West African Examination Council had begun to set school certificate examinations on the work of the new mathematics. And by 1971 the Primary School Mathematics syllabus had been revised and completely transformed into a modern mathematics syllabus and was sent out to all schools. In 1972, the traditional arithmetic was taught in the primary school side by side with such new topics as logic and sets, measurement, shape, space and statistics and probability (Mereku, 1995). Operations on number and sets were the topics that were emphasized in the syllabus. Currently, in the basic mathematics syllabus emphasizes is placed on topics such as operations on numbers, fractions, ratio and proportion and some application of percentages etc.

2.11 The Concept of an Area

The origin of the word area is from 'area' in Latin, meaning a vacant piece of level ground. The origin further led to an irregular derivation of area as 'a particular amount of space contained within a set of boundaries. We often find the area of the room floor to determine the size of the carpet to be bought. Covering the floor with tiles, covering the wall with paint or wallpaper or building a swimming pool are other examples, where in the area is computed. Area measurement has various applications in human life such as determining the area of a land, finding the number of tiles needed to cover a floor, area of a container to be packaged, etc. Area measurement is also related to other materials such as enlargement and similarity (Cavanagh, 2007). In integral calculus, the area under a curve can be estimated by the sum of areas of rectangles under the curve.

Area measurement is a part of geometry. There is more to area measurement than multiplying the length and width. Fowler (1987) states that due to the arithmetization on all areas in mathematics including geometry the area of a rectangle is seen as the product of the length and its base. He states that up to 2nd century B.C., Euclidean geometry seems to have been completely different and not arithmetized. Zacharos and Chasapis (2012) argue that geometry was related to the comparisons of quantities such as length, area, capacity, to mention a few. Zacharos and Chasapis (2012) argued that, measurement procedures are based on similar physical characteristics of the quantities being compared or measured such as in comparing an area, using surface. More importantly in Euclidean geometry, in dealing with area measurement, if we want to show that two figures have equal areas, we can divide one of the figures into parts and then fit those parts in certain ways to produce the second figure (Bunt et al., 1988).

However, in the criteria for equality of triangles this strategy is called 'overlapping' or 'epithesis' and this strategy can be used extensively to determine the equality of areas as well (Zacharos, 2006). In addition, dividing or parting and rearranging to produce a new figure involve knowledge of the concept of conservation of area. It means that breaking up the first figure into parts and rearranging from those parts to produce the second figure will not change the area of the original figure. The concept of conservation of area is a fundamental and preliminary aspect in students' understanding of the concept of area measurement (Piaget et. al, 1981;

Hirstein et al., 1978; Maher & Beattys, 1986 as cited in Kordaki, 2003). It is an important concept that students need to understand this concept and master in learning area measurement. Students might have experienced reshaping a figure without knowing that they apply the concept of conservation of area. Kordaki (2003) states that students can master the concept of conservation of area through the cut, move and paste activities that is rearranging the parts of a figure to produce a new one with an equivalent area. In addition, it is necessary to let students do those activities in order to understand the concept of conservation as prerequisite knowledge to understand the concept of area measurement (Kordaki, 2003). The procedure to measure an area involves the surface to be measured or compared. Therefore, area is closely related to surface. Baturo and Nason (1996) define area as an amount of region (surface) enclosed within a boundary and this amount of region can be quantified.

In everyday words, the area of a figure or object is the amount of 'stuff 'needed to cover the figure (Konya & Tarcsi, 2010). Moreover, there is a need to find the 'stuff' in order to make it easier to determine the area of a shape. Cavanagh (2008) states that area measurement is based on partitioning a region into equally size units that cover it without any gaps or overlaps. Here, the 'stuff' needed to measure an area is a unit of measurement. Reynolds and Wheatley (1996) state that to determine an area of a region can be done by comparing that region to another region like a square unit. They argue that in comparing regions that assigns numbers, there are four assumptions. The four assumptions are:

1. A suitable two-dimensional region is chosen as unit,
2. Congruent regions have equal areas,
3. Regions do not overlap, and
4. The area of the union of two regions is the sum of their areas.

Therefore, learning and teaching of area measurement can be taught through tiling activity (Reynold & Wheatley, 1996). In line with this statement, tiling activity can be used to teach students that area is a measure of covering (Konya & Tarcsi, 2010). Tiling activities use the idea of covering a region without any gaps or overlaps within certain tiles as units of measurement.

Stephan and Clements (2003) argue that there are at least four foundational concepts that are involved in learning of area measurement: (1) partitioning, (2) unit iteration, (3) conservation, (4) structuring array. Huang and Witx (2011) reveal that students with a good understanding of the concept of area and the area formula exhibited competency in identifying geometric shapes, using formulas to determine areas, and self-correcting mistakes. Meanwhile, students with a good understanding of multiplication that underlies the area formula, but who lacked understanding of the concept of area, showed some ability to use area formulas. Huang and Witx (2011) also state that the students who were unable to interpret the property of multiplication underlying the area formula irrespective of their conceptions of area exhibited the common weaknesses in identifying geometric shapes and in differentiating between area and perimeter. It is clear students need to a poor understanding of area measurement related to the processes used when they measure plane figures (Zacharos, 2006). In addition, Zacharos (2006) states that the way of teaching and learning of area measurement is responsible for difficulties and poor understanding of area measurement. Zacharos and Chassapis (2012) state that problems related to the understanding of mathematical concepts are due to a traditional approach in the teaching and learning of mathematics by overstressing the familiarization with algorithms and underestimating the importance of the comprehension of the concepts.

What students understand about area measurement in a traditional teaching is applying formulas. In a traditional teaching approach, mostly, teachers only give the procedural algorithms or formulas to determine areas of geometrical shapes. Students tend to memorize the formulas such as the area of a rectangle is base multiplied height ($A = bxh$). Cavanagh (2007) states the teaching and learning of area measurement will not be successful if it focuses too much on formulas instead of conceptual understanding. Therefore, what students learn in a traditional mathematics classroom is only memorizing a formula and applying it without having knowledge of the concept of area measurement and how and why the formulas work. As a result of this teaching approach (misconceptions), students do not understand the concept of area and face several difficulties in learning area measurement or in learning how to measure areas. Some studies have revealed that students at all levels experience difficulties dealing with area concepts (Cavanagh, 2007). Students think that an irregular figure does not have an area with the justification that the shape is strange and also it has too many sides (Cavanagh, 2007). Hirstein et al. (1978) as cited in Cavanagh (2007) posit that, only less than half of the seventh graders were able to do the task of determining the area of a shaded part consisting of full squares and triangles (half square) in the grid.

In this study, the design instructional activities mainly focus on the concept of conservation of area integrated with unit of measurements and re allotment. Students explored the concept of conservation of area by comparing and reshaping. In comparing, students need to overlap one region into another one and do cut and paste strategy in order to see which region is larger. Related to the conservation concept, students will reshape (re-allot) also some geometrical figures into a rectangle. Reshaping activity helped students to understand more about concept of conservation of area, perimeter and area, and the area formula of quadrilaterals. The next activity is comparing tiled floors that embed the unit of measurement. We can see a tiled floor as a region partitioned using two-dimensional unit. In tiling floors, people use different size and type of tiles. Normally, the floor is tiled using a square tile. Since there are different size of square tiles, students will compare the two floors with different size of tiles. Then students will see that the floor can be partitioned into different sub regions. In addition, comparing two floors with different size of tiles will also lead students to grasp the need of the same unit of measurement. This is called the unit iteration. Students will cover floors with unit of measurement, a square unit. In covering, a rectangular floor, students will cover fully the floor's surface. They will count the number of the tiles to compare. In counting the tiles, students may use multiplication strategy. It is the idea of the area formula of rectangle. Students will also cover non-rectangular (a parallelogram floor) floor that allows students to cut and paste the tile in order to cover the floor.

The concept of conservation of area is again used in combining the tile or square units. In dealing with rectangular floors, some students may only tile the edges of the floor instead of covering fully the floor's surface with the tiles. Students explore in structuring array by only cover the edges of the floor. Therefore, students will learn how the area formula of rectangle, base x height, works. Hence, students understand the area formula of rectangle. In the end of the lesson, students will reshape other quadrilaterals into a rectangle and derive the area formulas of parallelogram, trapezoid, rhombus and kite.

2.12 Students' Understanding and Misunderstanding of the Concept of Area

Huang and Witx (2011) reveal that students with a good understanding of the concept of area and the area formula exhibited competency in identifying geometric shapes, using formulas to determine areas, and self-correcting mistakes. Meanwhile students with a good understanding of multiplication that underlies the area formula, but who lacked understanding of the concept of area, showed some ability to use area formulas. Huang & Witx (2011) also state that the students who were unable to interpret the property of multiplication underlying the area formula irrespective of their conceptions of area exhibited the common weaknesses in identifying geometric shapes and in differentiating between area and perimeter. It is clear students need to have a good understanding of the concept of area before they learn the area formulas. Studies on mathematics education have often shown that students have a poor understanding of area measurement related to the processes used when they measure plane figures (Zacharos, 2006).

In addition, Zacharos (2006) states that the way of teaching and learning of area measurement is responsible for difficulties and poor understanding of area measurement. Zacharos and Chassapis (2012) state that problems related to the understanding of mathematical concepts are due to a traditional approach in the teaching and learning of mathematics by overstressing the familiarization with algorithms and underestimating the importance of the comprehension of the concepts. Mostly, Indonesian teachers teach area measurement by using a traditional approach. What students understand about area measurement in a traditional teaching is applying formulas. In a traditional teaching approach, mostly teachers only give the procedural algorithms or formulas to determine areas of geometrical shapes. Students tend to memorize the formulas such as the area of a rectangle is base x height (A= b x h). Cavanagh (2007) states the teaching and learning of area measurement will not be successful if it focuses too much on formulas instead of conceptual understanding. Therefore, what students learn in a traditional mathematics classroom is only memorizing a formula and applying it without having knowledge of the concept of area measurement and how and why the 8 formulas work. As a result of this teaching approach (misconceptions), students do not understand the concept of area and face several difficulties in learning area measurement or in learning how to measure areas. Some studies have revealed that students at all levels experience difficulties dealing with area concepts (Cavanagh, 2007). Students think that an irregular figure does not have an area with the justification that the shape is strange and also it has too many sides (see Cavanagh, 2007).

Hirstein, Lamb and Osbone (1978) (as cited in Cavanagh, 2007) reported in their study that elementary school students counted all regions equally regardless of their geometrical shape when using a grid. In their study, only less than half of the seventh graders were able to do the task of determining the area of a shaded part consisting of full squares and triangles (half square) in the grid. They treated the triangles as if these were the same units as the squares (Kamii & Kysh, 2006). Students also got confused between area and perimeter and wrongly used the slant height instead of the perpendicular height as the altitude (Cavanagh, 2007). For instance, students measured an area using the formula of perimeter or vice versa. Students also added the base plus the height instead of multiplying base with height to find the area of a rectangle (see Zacharos & Chassapis, 2012). Ozerem (2012) reports that seventh year secondary school students have a number of misconceptions and a lack of knowledge related to geometry subjects, such as using the wrong formula due to the lack of understanding of the concept of area and the memorization of formulas.

To sum up, students' difficulties are due to the traditional teaching that stress too much on the procedural algorithms and formulas instead of conceptual understanding. Therefore, innovations in teaching and learning of area measurement are needed to support students" understanding of area measurement.

CHAPTER 3

METHODOLOGY

3.0 Overview

The main aim of this chapter is to present and describe the methodology adopted for this study. The methodology as indicated in this chapter, describes for the reader important components of this study, such as research philosophy, research approach, research design, population, sample and sampling procedure, source of data, research instruments, validity research instruments and reliability of research instruments, trustworthiness of the interviews, data collection procedures, data analysis procedures and ethical consideration.

3.1 Research Design

Research design refers to the overall plan the researcher employs to collect data in order to answer the research questions including the specific data analysis techniques or methods. It spells out the basic strategies that the researcher intends to adopt to collect valid information that is accurate and interpretable. The model for this study is Action Research since it seeks to find solution to student's inability to solve angles problems effectively.

Cohen and Manion (2000). Defined action research as a small-scale intervention in the functioning of the real world and a close examination of the effects of such an intervention. Mills (2003) also defined action research as any systematic enquiry conducted by teachers, administrators, counsellors, or others with vested interest in the teaching and learning process, for the purpose of gathering data about how their schools operates or how they teach and how students learn.

Action research is preferred in this context because it deals with an intervention which is appropriate to a classroom situation in which the researcher carried out the study.

3.2 Research Approach

Research approaches are plans and the procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis and interpretation (Creswell, 2014). This plan involves several decisions, the overall decision involving the kind of approach most suitable to be used to study a topic. Informing this decision should be the philosophical assumptions the researcher brings to the study; research designs and specific research methods of data collection, analysis and interpretation. The selection of a research approach is also based on the research problem or issue being addressed, the researcher`s personal experiences and the audience for the study (Creswell, 2014). The approach for every research is usually dependent on the objectives and philosophical position of the researcher.

Research approach is essential as it enables the researcher to focus and look at in-depth of the problem and make a decision on how to solve the problem, naming, and approaching the research topic (Saunders, Lewis & Thornhill, 2012). In doing research the approach may be qualitative or quantitative or both (mixed methods approach).

The study adopted a mixed methods approach. The term mixed methods apply to research that combines alternative approaches within a single research project. It refers to a research strategy that crosses the boundaries of conventional paradigms of research by deliberately combining methods drawn from different traditions with different underlying assumptions. At its simplest, a mixed methods strategy is one that uses both qualitative and quantitative methods (Creswell & Creswell, 2018).

Mixed method approach provides the researcher with the opportunity to check the findings from one method against the findings from a different method. The use of more than one method can enhance the findings of research by providing a fuller and more complete picture of what is being studied. The benefit of the mixed methods approach in this instance is that the data produced by the different methods can be complementary (Agyedu, Donkor & Obeng, 2013). Researchers can improve their confidence in the accuracy of findings through the use of different methods to investigate the same subject. This approach allows triangulation of both qualitative and quantitative research strategies to elicit relevant information from the research participants (Cohen et al., 2011; Creswell, 2014).

Using the mixed method research approach provides strengths that offset the weakness of both quantitative and qualitative research approach and provides more comprehensive evidence for studying a research problem than either quantitative or a qualitative research approach alone (Creswell, 2014). Mixed method approach allows triangulation of both qualitative and quantitative research strategies to elicit relevant information from the research participants (Ravitch & Riggan, 2017; Creswell, 2014). The qualitative involves collecting data that is mainly in the form of words, and the quantitative involves data which is either in the form or can be expressed in numbers. It is often assumed that quantitative approaches draw on positivist ontologies whereas qualitative approaches are more associated with interpretive. A quantitative research is based on a positivist philosophy which tends to be based on deductive theorizing, where a number of propositions are generated for testing, with empirical verification then sought (Pandey & Pandey, 2015).

According to Creswell, a considerable data is often required as a positivist study would favour the use of quantitative method to analyse large-scale phenomena. Inherent in this overall approach to research is the view that it is possible to measure social behaviour independent of context and that social phenomena are 'things' that can be viewed objectively.

Qualitative research emphasizes on subjective interpretation (Bryman, 2012) and facilitates effective and in-depth understanding of the research topic (Best & Kahn, 2006). The qualitative research method provides a deeper wedge and insight into a particular phenomenon, by providing answers to questions of "how" rather than "what"? (Goldkuhl, 2012).

3.3 Population for the Study

According to Welsh (2006), a population is any group of individuals that have one or more characteristics in common that are of interest to the researcher. Similarly, McMillan and Schumacher (2010), see population as a group of elements or causes, whether individuals or objects or events, that conform to specific criteria and to which one intends to generalize the results of the research. The accessible population for the study was all the students in Nifa Senior High School.

3.3.1 Target population

The study targeted all the second-year students of the school. However, the researcher only focused on the form 2B1 student due to convenience. Also, the researcher did not cover other form two classes but since they all do the same content; is likely they encounter similar difficulties with the concept of area of quadrilaterals. The target population consisted of 823 students which consist of 420 female and 403 males.

Table 3.1: The population of SHS 2 students in Nifa Senior High School

Students	Frequency	Percentage(%)
Male	403	48.9
Female	420	51.1
Total	**823**	**100.0**

Source: Nifa Senior High School ICT Unit.

3.3.2 Study population and sample

Burns and Grove (1993) define a population as all elements (individuals, objectives, and events) that meet the sample criteria for inclusion in a study. The population of the study was extracted from the Students' academic register. The study population considered for the study was 823 students.

Burn and Grove (1993) also defines a sample to involve the examination of a carefully selected proportion of the units of a phenomenon in order to help extend knowledge gained from the study of the part to the whole from which the part was selected. Therefore, a sample size of forty – two (42) was selected from a population of 823 students. The National Education Association Research Bulletin (1960) published the formula below for determining the sample size for known population size.

S = $X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$

S = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confident level (3.841)

N = the population size

P= the population proportion (assumed to be 0.50 since this would provide the maximum sample size

d= the degree of accuracy expressed as a proportion (0.05)

Furthermore, Mouton (1996) defines a sample selected with the intension of finding out something about the total population from which they are taken. A convenient sample consists of subjects included in the study because they happen to be in the right place at the right time (Polit & Hungler, 1993).

3.3.3 Sample criteria

Respondent included in the sample were selected to meet specific criteria. The students of Nifa senior High school had to meet the following criteria to be included in the sample.

Be a form 2 student and of either sex

3.4 Sampling Procedure

Sampling is a process of selecting a number of individuals for a study in such a way that they represent the larger group from which they were selected. Welsh (2006) defines sampling as the process of choosing from a much larger population, a group about which we wish to make generalized statements so that the selected part will represent the total group. In this study, the purposive and convenience sampling techniques were used to select the sample class and students for data collection.

Cohen et al. (2011) define purposive sampling as sampling for a purpose and picking a group who fit a profile. Purposive sampling can be used to select various groups of respondents to interview. According to Annan (2007), purposive sampling can increase range of data and maximize the possibilities of uncovering multiple realities that would occur in the study. The sample of the second-year students were purposively selected because the study focused on the teaching methods, the effects of teaching methods on the students' performance of the second-year students in the Nifa Senior High School. The purposive sampling method allowed the researcher to acquire information that would build up arguments towards a deeper understanding of participants' reasons for choosing the methods of teaching.

In this study, a non-Probabilistic sampling procedure was used. Also Convenient and purposive sampling procedure were used since the model used is action research. Convenient sampling was adopted because of logistical financial constraint and easy accessibility of the students bearing in mind the track system.

3.5 Research Instruments

In both qualitative and quantitative studies, the investigator serves as the primary instrument to gather data (Kothari, 2004). According to Yin (2003), there are different sources of information when conducting a case study: documentation, archival records, interviews, direct observation, participant observation and physical artefacts. Methods used in data collection include observations, interview, and test. Data was also gathered from different documents and data resources according to the situations of teaching and learning.

3.5.1 Observations

Observation is a powerful tool that offers the researcher the chance to gather live data from social situations as they emerge, get inside situations, and observe what is happening, thus collecting more valid and authentic data (Cohen et al., 2007). Simpson and Tuson (2003) argued that observations have several strengths as a tool for gathering data; however, observations are prone to difficulties and weaknesses. Observation collects research data, which involves observing behaviour and systematically recording those behaviors' results.

The observation was conducted throughout the meetings sections with the students during teaching, group work sections and presentation of findings. The researcher developed an observation guide and used it to record students' activities in the classroom.

Below is the step-by-step itinerary of observing the sample.

a. Students' effort at getting familiar with the geometric visualizing.
b. Students used teaching and learning materials correctly and recorded findings down.
c. Students showed keen interest in using the teaching and learning materials to solve area of quadrilaterals questions.
d. Students compared the constructivist approach and the traditional approach of teaching area of quadrilaterals.

The points of interest for the researcher in the observation included ease of use of the teaching learning materials, use of teaching learning materials in solving area of quadrilaterals problems and how constructivist approach enhanced students' Geometric thinking through the exhibition of specific skills. The observation covered the Geometric skills students acquired during the intervention.

3.5.2 Interview

An interview is a verbal conversation with the objective of collecting relevant information for the purpose of research work (Amoah & Eshun, 2015). Interviews can be classified into structured, semi-structured, and unstructured by their nature (Fellows & Liu, 2015). An unstructured interview starts with introducing the research topic and then records the replies from the respondents. The structured or standardized interview requires the researchers to develop an interview schedule that lists the questions' wording and sequencing. Semi-structured interviews are a combination of both structured and unstructured interviews such as, a researcher will come up with a list of questions to be asked in the interview, but the researcher can make follow-up questions to get deeper detail or explanation from the respondent on the basis of his response. Semi-structured interviews are conducted on the basis of a loose structure consisting of open ended questions that define the area to be explored, at least initially, and from which the interviewer or interviewee may diverge in order to pursue an idea in more detail (Given, 2012).

In view of this, the researcher used a semi-structured interview with open-ended questions because the researcher did not want the interviewees to be constrained in their answers. Creswell (2009) argues that the more open-ended the questioning, the better the researcher listens carefully to what people say. Interview guide was developed in line with the research questions. The interview questions were five (5), and they aimed at eliciting students' responses on the effectiveness of using constructivist approach of teaching and learning to enhance students' Geometric thinking and understanding the concept of area of quadrilaterals. The interview also covered the feasibility of the constructivist approach of teaching area of quadrilaterals in senior high schools. The interview was audio-recorded and transcribed. The researcher used at least ten minutes to complete an interview on a participant. The interview followed immediately after the intervention.

Ten (10) students were randomly selected for the interview. The interviews focused on the following issues:

i. Students' views on how constructivist approach of teaching has enhanced their content knowledge in area of quadrilaterals.
ii. The usage of teaching learning materials in teaching and learning area of quadrilaterals.
iii. Were there any constraints in learning area of quadrilaterals using the constructivist approach of teaching and learning.

iv. How feasible is the use of constructivist approach of teaching and learning area of quadrilaterals in the senior high schools?

v. Factors that could affect the feasibility of the constructivist approach of teaching and learning in the senior high schools.

3.5.3 Test

Test was conducted both before and after intervention. The pre-test and the post-test for students were ten questions each on area of quadrilaterals. The pre-test was set based on students' previous knowledge of circle theorems in the traditional method. The post-test was conducted after intervention (teaching using the constructivist approach).

3.5 Source of Data

3.5.1 Primary data

Primary data refers to data collected or obtained from first-hand experience. Primary research consists of a collection of original primary data. It is often undertaken after the researcher has gained some insight into the issue by reviewing secondary research or by analysing previously collected primary data. It can be accomplished through various methods. The researcher employed the use of first-hand information from test results from students exercise conducted.

3.5.2 Secondary data

Secondary data is any information collected by someone else other than its user. It is data that has already been collected and is readily available for use. Secondary data saves on time as compared to primary data which has to be collected and analysed before use. Secondary data were elicited from documents such the school's register.

3.6 Data Analysis

The researcher adopted descriptive statistics method of analysing the data in a form of marks range in percentages, means, standard Deviation and Grades with interpretation was employed to enhance the discussion. Descriptive statistics was useful because they make it easy to compare and contrast the performance of students easily (King, Keohane & Verba 1994). Quantitative analysis collects data that is factual and can be measured and considered statistically, (Copper & Schindler, 2006).

The quantitative data were analysed, using the Statistical Package for Social Science (SPSS) software. This software was chosen for the data analysis because it is reasonably user friendly and does most of the data analysis one as far as quantitative analysis is concerned. SPSS is also by far the most common statistical data analysis software used in educational research (Muijs, 2004). The data entries were done by the researcher in order to check the accuracy of the data. The responses from the interventions (Pre and Post Tests) were all tabulated to support the discussion of the results.

3.7 Validity of the Instruments

Creswell (2005) the goal of a good research is to have measures that are reliable and valid. Validity is the extent to which a test measures what is intended to measure (Stephanie, 2017). According to Taherdoost (2016), the instrument`s validity is the subjective assessment of relevance and the presentation of its items. Validity is an important feature for an instrument (Wiersma, 2000). It is a measurement tool which is considered to be the degree to which the tool measures what it claims to measure. Correctness of information was checked by the use of relevant instruments such as questionnaire, observation, interview, and achievement test. The questionnaire was piloted and reviewed and recommendations were made on formulated instruments that had the ability to obtain the expected relevant data. Students were interviewed personally to obtain data on teaching and learning, and factors affecting students' performance.

a) Face validity

Face validity is a measure of how representative a research project is 'at face value,' and whether it appears to be a good project. Face Validity refers to the appearance of validity to test users, examiners, and especially and the examinees. Bryman (2012) opined that face validity might be established by asking other people whether the measure seems to be getting at the concept that is the focus of attention. In other words, people, possibly those with experience or expertise in a field, might be asked to act as judges to determine whether on the face of it the measure seems to reflect the concept concerned (Bryman, 2012). In order to ascertain face validity, the researcher presented the instruments constructed to his colleague Master of Philosophy Mathematics Education students for constructive criticisms.

b) Content validity

Content validity is the extent that a research instrument covers the content that it is intended to measure. It also refers to whether an instrument provides adequate coverage of a topic. Expert opinions, literature searches, and pretesting of open-ended questions help to establish content validity (Zohrabi, 2013). Creswell (2013) stated, "It is the extent to which the questions on the instrument and the scores from these questions represent all possible questions that could be asked about the content or skill". The researcher prepared the instruments in close consultation with his supervisor and senior lecturers of the Department of Mathematics Education and ensured that the items in the questionnaire and interview guide cover all the areas under investigation. Best and Khan (2006), pointed out that content validity of the research instruments is enhanced through expert judgment. The researcher's supervisor and lecturers, as experts, helped to assess the validity of the instruments.

3.8 Pre-Intervention

Day 1

The researcher organized class, one period (1 hour) using lecture method to take students through the topic area of quadrilaterals. After the class the researcher conducted a test (pre-test) to access students' performance and collect baseline data on difficulties students' encounter solving problems involving area of quadrilaterals, in order to intervene immediately.

Day 2

The researcher organized a second class (1 hour), lecture method to address students problems encountered during the first lesson as well as mistakes made during the first pre-test.

Day 3

Students were made to undertake 45 mins paper as a pre-test. Questions on basic concepts on area of quadrilaterals and its application were given to students. The researcher held a discussion with students to find out how they understood the questions and why they answered the way they did. The researcher realized that students tried to apply formulas they have memorised but in most of the case, some aspects of the formular were missed and caused their poor performance. There was therefore the need to intervene using an activity method to enhance understanding of the concept of area of quadrilaterals.

3.9 Intervention Design

The findings from the pre-test necessitated the researcher to use student-based approach (constructivist) to plan a lesson and teach in the intervention class. Students were made to bring measuring tools and graph sheets or books to class for the lesson. Students were taken through several step-by-step activities throughout the lesson on three different meetings (one hour each) each addressing an objective to enhance thorough understanding of area of quadrilaterals.

3.9.1 Intervention activity one-identification of quadrilaterals

The researcher began by reviewing students' relevant previous knowledge in geometry on plane shapes specifically quadrilaterals. The researcher went on to put students into 8 groups with 4 students in each group. Each group was made to draw on a sheet three quadrilaterals and name them. Properties of the various quadrilaterals were discussed briefly.

Figure 3.1: Properties of quadrilaterals

Source: Mathmonks.com

Properties of a Parallelogram: Diagonals bisect, opposite sides congruent, opposite sides parallel, consecutive angles supplementary, opposite angles congruent.

Properties of a Rhombus: all of the properties of a parallelogram, consecutive sides congruent, diagonals perpendicular, diagonals bisect angles.

Properties of a Rectangle: all of these properties of a parallelogram, all right angles, diagonals congruent

Properties of a Square: all of the properties of a parallelogram, rectangle, and rhombus, all sides are congruent, all right angles

Properties of a Trapezoid: only one set of parallel sides, diagonals congruent, opposite angles supplementary, base angles congruent, non-parallel sides are congruent.

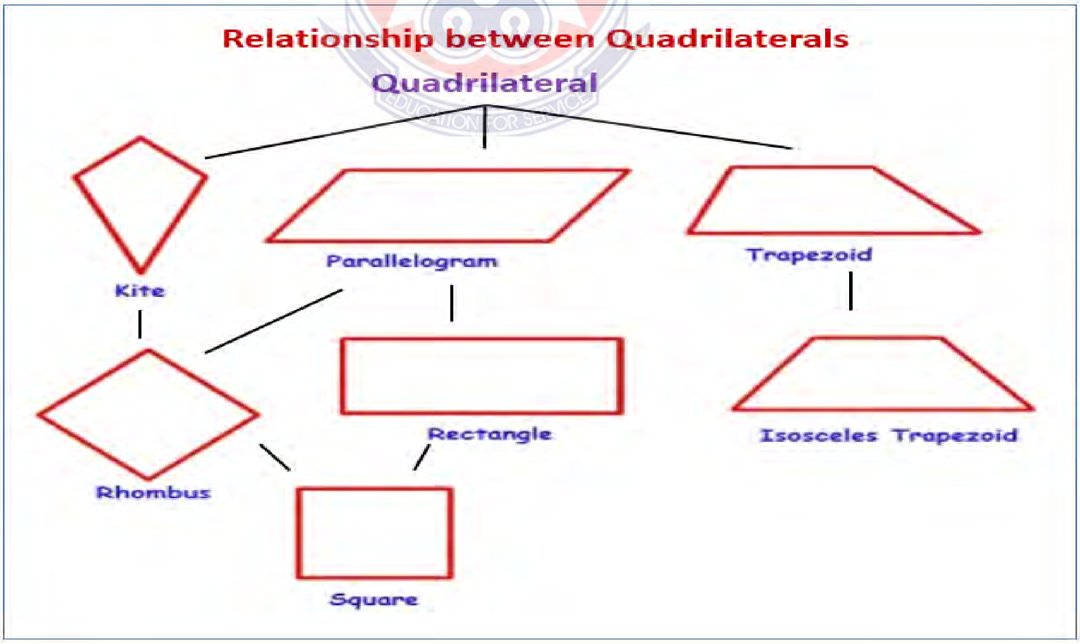


Figure 3.2: Relationship between quadrilaterals

Source; Mathmonks.com

Jigsaw Method

Once students have been introduced to quadrilaterals and their basic properties, the jigsaw method was used to further explore the types of quadrilaterals. The following steps were used:

1. The class was divided into groups of four. Within each group a student was assigned to be a rectangle, square, rhombus, or trapezoid.
2. The "expert" from each group will leave their home group and meet together with the experts from the other teams. For example, all the rectangles will meet in one corner, the rhombi in another, and so on.
3. Each group was provided with a guided activity that will allow members to explore their shape and learn its properties. The group members must come to a consensus on the properties and feel confident that they can teach these properties to their home teams.
4. The "expert" group (formed) for each figure prepares examples, diagrams, properties, and three quiz questions to share with their home teams.
5. After the allotted time, students return to their home teams to share their knowledge with their respective groups (Posamentier, Hartman, & Kaiser, 1998).

Vocabulary Enhancement

Finally, to reinforce new vocabulary explored, students participated in a group game that focused on the properties of each quadrilateral. The researcher went through the following steps:

1. Divided the class into groups of four students.
2. Provided each group with a "construction bag" containing items such as straws, toothpicks.

3. Provided each student with a card that contains the description of one of the quadrilaterals studied.
4. Each student must use the items in the bag to construct the quadrilateral on his or her card, making it identifiable to others in his or her group.
5. Using their definitions, students must justify the construction of the figures.

Students were then asked to mention some things they see in the communities with the shape of any quadrilaterals. Exercise was given to be done individually on types of quadrilaterals and their properties.

3.9.2 Intervention activity two-finding area of rectangles and squares using graph sheet and grid paper

To explain the concept of area as space covered by an object, the researcher used grid paper, graph sheet to illustrate to students. Put students into groups of four members each and guided them to find the area of several rectangles and squares using the graph sheets and grid paper. Guide them come out with the general formula for rectangles and squares in general based on findings.

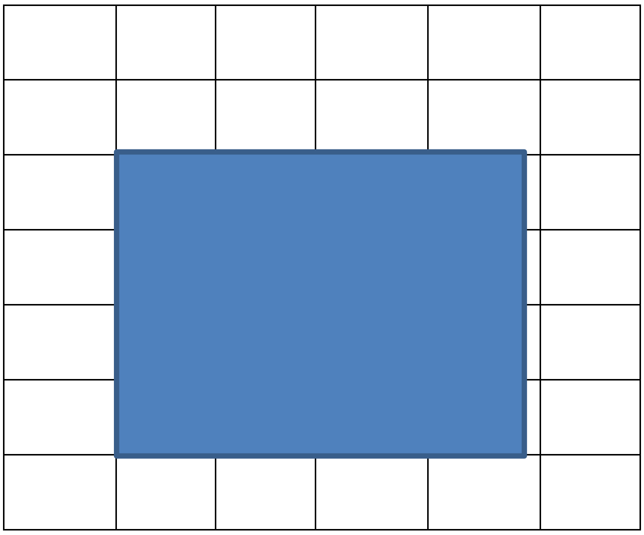


Figure 3.3: Square on a grid paper

Source; commons.wikimedia.org

Some students counted the number of squares the shape covered, whiles other students determined the area of rectangles by multiplying the number of squares it covered on the length and the width. Since they have been familiar with the multiplication strategy, they multiplied the length of the sides of the rectangles and deduced the area formula of rectangle as length x width. Students were made to draw rectangle and square on their graph sheets with a given dimension. They were again asked to use their rules to draw rectangles and squares given dimensions and find the area. This was followed with a discussion introduced by questioning.

After the discussion, the researcher and the students concluded together what they leant. The main conclusions were:

- the area of a rectangle can be found by multiplying its length of base and width (length x width)

3.9.3 Intervention activity three-comparing size of quadrilaterals

Students were taken through comparing two figures by overlapping, cutting and pasting by which it was understood that by cutting and pasting will not change the area of its original figure. This starting point is relevant to let students explore more about reallotment activity. Students were given cut out shapes to compare their sizes. This necessitated cutting one shape to reallot on the other to be able to compare the sizes well. In the lesson they learnt that the reallotment activity will preserve the area but not the perimeter. Again, with the reallotment activity, students were guided to also reshape other quadrilaterals into a rectangle.

The learning goals;

The students are able to

- do overlapping to compare two shapes

- understand the concept of conservation of area.
- understand that when they cut and paste (reallot) the shape and make into another shape preserve its original area but not the perimeter.
- reshape figures into a rectangle.

Reallotment Task

In this task, students learnt more about reallotment activity. The problem in the task was designed to lead students explore more about reallotment activity to deepen their understanding of quadrilaterals . The context was which shapes had the same area.

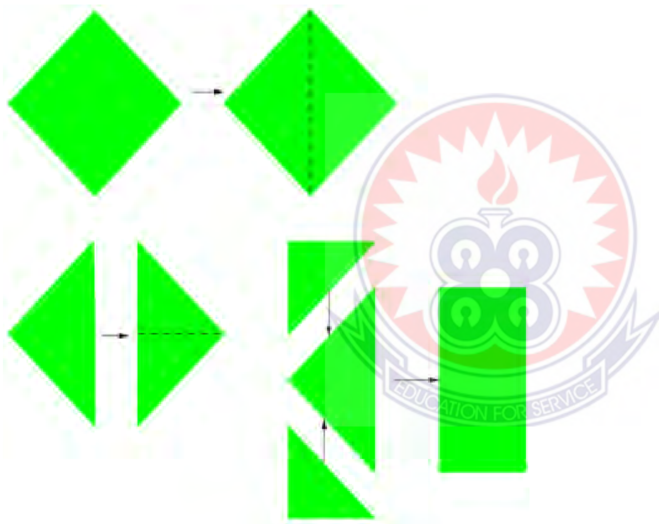


Figure 3.4: Reallotment of rhombus into rectangle

Source : Thinglink.com

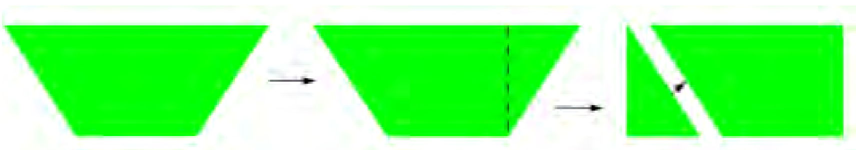


Figure 3.5: Reallotment of trapezium into a rectangle

Source: Thinglink.com

The teacher provided materials like strings, pins, scissors and glue. Students cut out shapes that looks bigger, longer, or wider using their perceptional justification and compared the area by overlapping, cutting and pasting.

Task 2 (Individually)

Reshaping is based on the reallotment activity that students made new shape from a given figure. In this task, students reshaped the geometrical figures like a parallelogram, a trapezoid, a kite and a rhombus into a rectangle. Some students randomly cut and paste the figures using try and error strategy. However, some students noticed how to reshape the figures into a rectangle.

Discussions were held after the task with a preceding question, what changes students noticed after reshaping. They answered that the shape changes, the area remained the same and the researcher moderated students to draw their conclusion. The main conclusions were:

- Reallotment activity by reshaping or cutting and pasting will preserve the area
- Reshaping into a rectangle will be useful to find the area.
- The area is region inside/ within the boundary.

Task 3 (Group)

Using tiled floor as an example, students explored covering some cut-out shapes (representing floor) with other smaller rectangular and square cut out (as tiles).

The task was to determine which big shape ((floor) is larger. The rectangular big shapes (floors) are easier to tile but the parallelogram shape (floor) was not easy to tile. Students needed to cut further some of the small shapes (tiles) to cover some parts of the big shape (floor). In comparing the areas of the big shapes (floors), they compared the number of the small shape (tiles). In determining the number of the tiles on each floor, they had to count one by one or used multiplication strategy. Some students just put or drew some tiles on the sides of the floor, (a row and a colum) then used multiplication strategy to find the number of the tiles on that floor. However, in the floor with parallelogram shape, they had to cover the entire floor using the tiles and adjusted some of the tiles by further cutting them.

Task 4 (Individual)

The next problem was that students needed to find the areas of two floors from a given dimension of a tile (25 cm x 25 cm). Students were expected to determine the area of the floors using multiplication strategy by knowing the number of tiles on the edges of the floors. After getting the number of the tiles they had to multiply it by 625 since each tile has the area of 625 cm^2

In the next problem, two figures or shapes can be compared only by using the same unit of measurement.

The next task, students were asked to explore the relation between a rectangle and a parallelogram to derive the area formula for a parallelogram. The context was about a building with its side has a parallelogram shape. The teacher showed the picture of the building on a chart. There were two buildings in the problem that students needed to determine the area of glasses to cover the side of the buildings.

The first building had a rectangular shape on its side meanwhile the second building has parallelogram shape on its side. Students were to solve the problem by counting the number of the square unit of glasses in the rectangular building. Students were to count one by one or use the multiplication strategy. After students get the number of the square units, students multiplied it with 49 m^2 since each square unit has an area of 49 m^2 and had the area to be 1960 m^2

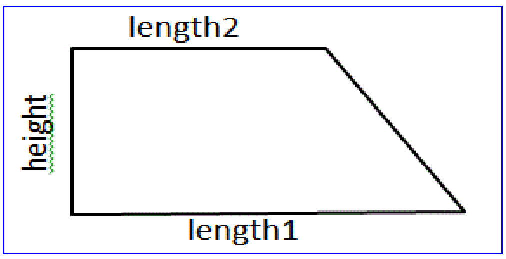
Some students also measured the length of the base and the height of the building then multiplied the lengths (35 m x 56 m) to get the area of the glasses.

In dealing with the parallelogram building, students could not easily count the number of square units. They needed to reshape this building into another shape for instance rectangle (see figure 4.14). Students will easily reshape this building since they have experienced the reshaping activity. Students got the rectangle and then found the area by counting one by one the square units or using multiplication strategy. Student also found the length of base and height and multiplied those lengths and got the area as 35 m x 56 m or 1960 m^2 Students compared the area of glasses of the two buildings and found out that the area is equal.

In the next problem students were to deal with finding the area of parallelograms from a given base in the grid paper. Students needed to determine the areas of parallelograms. Students solved the problem by reshaping the parallelograms into a rectangle and use the multiplication strategy.

Some students also directly multiplied the length of the base and height since they have noticed that the formula works out this way since base and height remains the same.

Students were guided to find the area of a rhombus, kite and trapezium.



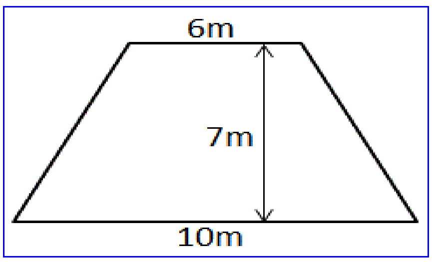


Figure 3.6: Trapizium

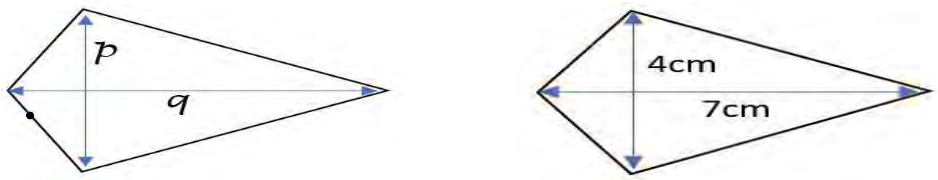


Figure 3.7: Kite

The main conclusions were;

- area of parallelogram is multiplication of the base and the perpendicular height
- area of rhombus is multiplication of the length of the two diagonals divided by two or multiply the base (length of one side) by the height.
- area of kite is multiplication of the length of the two diagonals divided by two
- area of a trapezium is half the sum of the two parallel sides multiplied by the actual or perpendicular height.

3.9.4 Activity four-application of area of quadrilaterals

Researcher concluded lesson with practical applications of area of quadrilaterals.

1) The area of trapezium is 84 Sq.cm and height is 8 cm. The parallel sides are in the ratio 2: 5. Find the length of the bases.

Solution:

Area of trapezium = 84 Sq.cm

Height of trapezium=8 cm

Let the parallel sides be 2x and 5x

Area of trapezium = 1/2 *height*(base 1+base 2)

84=1/2 *8*(2x+5x)

84= 4*7x

Dividing by 28 on both sides,

X=3

The parallel sides are 2*3 and 5*3

Therefore, the parallel sides are 6 cm and 15 cm.

2) Mr. Kuma purchased a carpet for rectangular hall of area 800 sq. yards. The length of the hall is 32 yards. Find the required width of the carpet.

Area of rectangular hall = 800 sq. yards

length of rectangular hall = 32 yards

Area of rectangle = length x width

Therefore width = area / length

Width=800/32

Width = 25 yards

3) A rectangular swimming pool was constructed for Kids at Hotel Park. The length of the swimming pool is twice its width. If the length is 16 ft, find the width and area of the pool.

Length of swimming pool = 16 ft

Length of swimming pool = 2 x width

Length of swimming pool / 2 = width

Width = 16 / 2

Width = 8ft

4). The base of the parallelogram is 11 inches and its area is 132 inches. Find the height of the parallelogram.

Solution

Area of parallelogram = base x actual height

Area of parallelogram / base = actual height

132 inches / 11 inches = 12 inches

Height = 12 inches

Post-Test

Another test was conducted after the use of constructivist approach (intervention) to teach students the concept of area to find out the reliability of the approach (i.e. the effect of task on the performance of students. The post-test was aimed at finding out how effective the intervention had worked.

Students were made to undertake an hour (1hr) paper as a post-test. Questions on basic concepts on area of quadrilaterals and its application were again given to students. The items used for the post-test 1 were the same as those used for the post-test 2. The researcher used the same criteria for marking both the pre-test and the post-tests. The post-test 2 entailed all the questions used in the interventions and pupils were expected to answer them as written test.

Some questions from the pre-test were repeated and new ones added. The researcher marked the pre-test with the marking scheme (see appendix). Discussions were again held to address some mistakes. Marks recorded in this test were used in the analysis of the study.

3.10 Credibility

Credibility in qualitative research deals with the extent to which the findings from the study measure reality (Morrow, 2005). According to Gasson (2004), it implied "how we ensure rigor in the research process and how we communicate to others that we have done so" (p. 95). In essence, it deals with the methods of ensuring that the researcher has analysed the data correctly. Strategies to ensure this, as proposed by Guba (1981) and buttressed by Shenton, (2004) include:

1. Prior familiarisation with participants to gain adequate understanding and build a relationship of trust
2. Ensuring honesty in the reports of participants by informing them of their right to voluntary participation and withdrawal. This ensures that only those genuinely interested are involved, thus guaranteeing accuracy of their responses
3. Member checking with participants, by returning the data to them after analysis
4. Peer checking, which involves a panel of experts or experienced colleagues reviewing or reanalysing the data
5. Regular debriefing sessions between the researcher and the supervisor. Through such discussions the researcher is kept abreast of impending flaws and notified when his/her biases begin to creep into the data
6. The degree of congruence between findings from previous studies with similar focus and the present one.

Based on these, to ensure credibility, the researcher became familiar with the informants by building a rapport with them before the data collection and presented to them an informed consent form which explained in detail the essence of the study and their right to voluntary participation and withdrawal. The researcher also included direct quotations from the text in the presentation of the findings, which according to Graneheim and Lundman (2004) also reflected the credibility of a study. Also, throughout the period of the study there were regular discussions between the researcher and the research supervisor, and during these sessions, we deliberated on the best approach and methodology for the study as well as the instruments for data collection. At the end of the transcription process, the data also presented to the research supervisor for him to add his expert knowledge to it.

3.11 Dependability

According to Lincoln and Guba (1985), dependability "seeks means for taking into account both factors of instability and factors of phenomenal or design induced changes"; this means taking note of the changes in data and those made by the researcher during the process of data analysis (p. 299). In other words, it means description of the research process, to allow for replication (Marrow, 2005), even though the intent is not to generate the same results (Shenton, 2004). Ensuring dependability of the study implies that the researcher would take cognisance of the extent to which necessary research ethics and practices are observed (Shenton, 2004). To achieve dependability for the study, the researcher needs to provide detailed description of the research process vis-à-vis the design, data gathering and methods used (Marrow, 2005; Shenton, 2004). In view of this, the researcher planned in clear terms the instruments to be used for data collection, and the method and general design for the study at the beginning of this chapter. To ensure research ethics, the researcher obtained clearance for the study from the research Head of Mathematics Department of UEW, as well as permission from the head master of Nifa Senior High School; this gave the researcher a nod to proceed with the research and have access to the participants.

3.12 Transferability

According to Morrow (2005), this implied the extent to which the findings from a particular study can be applied to wider situations. Shenton (2004) however, contended that since qualitative studies consider only a small population, it is difficult to say that their findings can be applied to wider situations. Bassey (1981) posited that the findings can only be applied when the situations and populations are considered to be similar to those used in the study. To determine this, Firestone (1993) suggested that the researcher provided adequate information on the general design and approach of the research, so as to guide readers to make informed decisions on its transference. In line with this, Graneheim and Lundman (2004) proposed that there should be a clear description of the context, sample and sampling procedure, processes of data collection and analysis, as well as explicit and intense presentation of findings of the research, which may be done by way of inserting direct quotations from the transcribed data into the research report.

In view of this, earlier in the chapter, the researcher provided details of the context, sample, sampling technique, data collection and analysis of the study, which made it easy for the reader to decide on its transferability. Also, the researcher included direct quotes from the transcribed text, so as to add to the richness of the findings that was presented. While the researcher stated as part of the limitations of the study that its findings may not be generalised to other situations, as suggested by Morrow (2005), the steps as proposed guided the reader to determine the transferability or otherwise of the study.

3.13 Confirmability

Confirmability of qualitative research means ensuring that the findings reflect the experiences of the participants and not the prejudices or bias of the researcher (Shenton, 2004). In order words, “findings should represent, as far as is (humanly) possible, the situation being researched rather than the beliefs, pet theories, or biases of the researcher” (Gasson, 2004, p. 93).

This construct assumes that the strength of the research findings lie in the ability of the researcher to link together the data, process of analysis and findings in such a way that gives room for confirmation of the accuracy of findings (Morrow, 2005). Thus, in ensuring comfirmability:

1. Morrow (2005) suggested the use of a variety of data collection sources, methods and perceptions (triangulation)
2. The research report should provide a justification for the chosen method, assumptions and approach used, as well as a statement of the weaknesses of such techniques (Shenton, 2004). In addition, the researcher should adopt reflexivity, by stating the assumptions that undergird the framing of the research questions and presentation of findings (Morrow, 2005)
3. The researcher should provide an audit trail by documenting and providing step-by-step details of the entire research process (Guba, 1981; Shenton, 2004).

Going by these suggestions, the researcher ensured that she puts aside her opinion in the analysis of the data by reading the transcripts over and over again, such that the researcher became familiar with the ideas therein, which was evident in the description of the data analysis process, which was presented in the report. Also, the researcher ensured that it that he provided a justification for the methodology used for the study by referencing appropriate authors and gave a clear description of the manner in which the data was collected and analysed, such that the reader finds it easy to decide on the acceptability of the findings. Furthermore, the researcher used triangulation by varying the sources of the data that was collected.

3.14 Privacy

After addressing the ethical issues of access and informed consent, participants were assured that the research will not intrude their privacy. The privacy of participants is the right they preserve. For this reason, the researcher ensured privacy by giving participants the opportunity to withhold information they deemed sensitive and personal. They were given the right to decide which personal information to be given under which circumstances that could be provided. Again, the researcher made sure that their dignity, status and self- esteem were not threatened through their participation by asking less sensitive questions.

3.15 Confidentiality

In ensuring confidentiality, information given by participants remained protected by not sharing it with any other user. Again, confidentiality was ensured by using the information provided by participants for the purpose for which it was collected. Also, the researcher did not involve any assistant, thereby guiding against the possibility of having participant`s information exposed to a third party.

3.16 Anonymity

Anonymity was also another ethical issue that was considered in conducting the study. Here, the researcher ensured that identities of participants were not identified from the information they provided. In doing so, the personality of respondents was detached from the findings by providing no form of trace to the specific sources of information. Again, the names of participants were not contained in the report.

3.17 Reporting

In terms of data reporting, respect was again showed to the audience that would read and use information from the research. In this wise, data gathered from participants was reported honestly without altering the findings to satisfy certain interest groups or preconceived notions. Regarding the language for reporting, the report was free of jargons and as much as possible understandable to those being studied.

CHAPTER 4

DATA ANALYSIS AND RESULT

4.0 Overview

This chapter presents the results and findings based on the main purpose for this study i.e., how the use of constructivist approach of teaching and learning can improve performance of senior high students specifically in relation to the concept of area of quadrilaterals. The chapter begins the demographic characteristics of the respondents. The findings of the descriptive result of the various score of the students followed.

The chapter also presents the analysis of the data collected and the results or inference that can be made based on this data. The data will be presented in the form of frequency tables, and bar charts to make the findings more comprehensive. In order to analyse the collected data, the SPSS software version 16.0, and the Spread sheet Excel was considered.

The final section is a summary of the research hypothesis, and then the chapter is concluded with a summary of the entire chapter.

4.1 Demographic Characteristics

This section sought to present results on the demographic characteristics of the student used for the study. The only demographic characteristics assessed in this study was gender. Table 4.1 summarise the results of the gender composition of the students.

Table 4.1: Gender of students

Gender	Frequency	Percentage (%)
Male	24	57
Female	18	43
Total	**42**	**100**

Source: Field Estimation, 2020

From Table 4.1, out of the total of 42 students used for the study, 24 representing 57% were male while the remaining 18 representing 43% were female. This indicates that the class in which the study was conducted was dominated by males.

4.2 Presentation of Pre-intervention Tables

On a score range of 0-20, the scores obtained by students is presented in table 2, thus analysis of the pre-intervention test.

Table 4.2: The pre-intervention marks of form 2B1 class

Marks	Number of students	Percentage (%)	Marks's interpretation
0-5	30	71	Low marks
6-10	10	24	Below average
11-15	2	5	Average marks
16-20	0	0	High marks
	42	**100**	

Source: Field Estimation, 2020

From Table 2, no student scored marks from 16-20 (high marks) with only 2 students representing 5% had average marks. Ten (10) students out of 42 representing 24% scored between 6-10 marks representing below average. Whiles 30 students representing 71% scored between 0-5 marks (low marks). This result testifies that majority of the students performed poorly in the pre-intervention test.

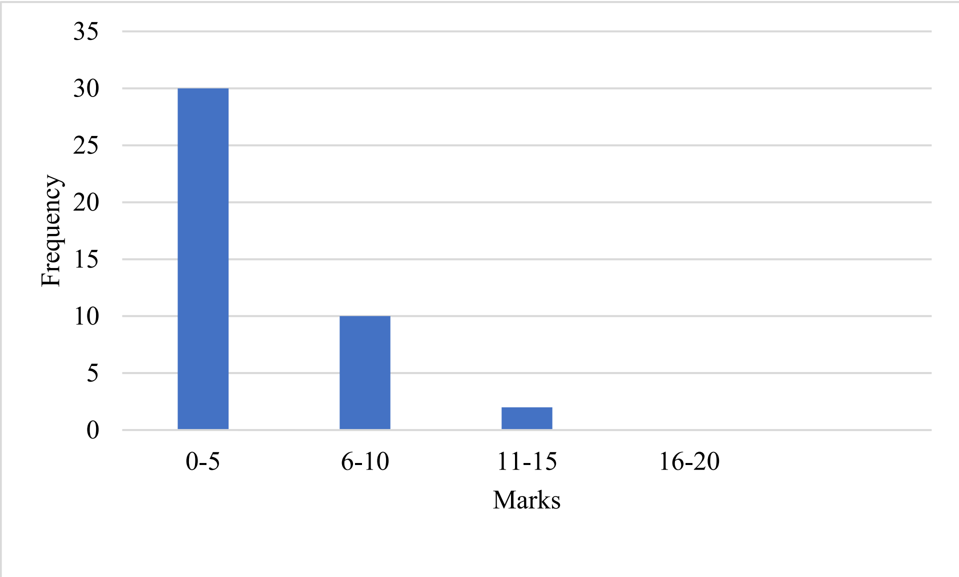


Figure 4.1: The pre-intervention marks of form 2B1 class

From the chart, it is observed that the number of students reduces as the marks increases. There is a sharp drop from 30 to 10 students as the marks increases from 0 to 10 (out 30), which indicates that a lot of students did not perform during the pre test which can be associated to the fact that students did not understand concept well.

Presentation of Post Intervention Tables

Table 4.3: The post intervention marks of form 2B1

Marks	Number of students	Percentage (%)	Marks interpretation
0-5	4	9.5	Low marks
6-10	8	19	Below average
11-15	19	45.2	Average marks
16-20	11	26.3	High marks
	42	100	

From Table 4.3, 11 students (26.3%) scored marks from 16-20 representing high marks, 19 out of 42 students had average marks (45.2%) with 8 students representing 19% had below average marks. Four (4) students out of 42 representing 9.5% scored between 0-5 marks representing below average. This result testifies that majority of the students performed better in the post-test (after the use of constructivist approach).

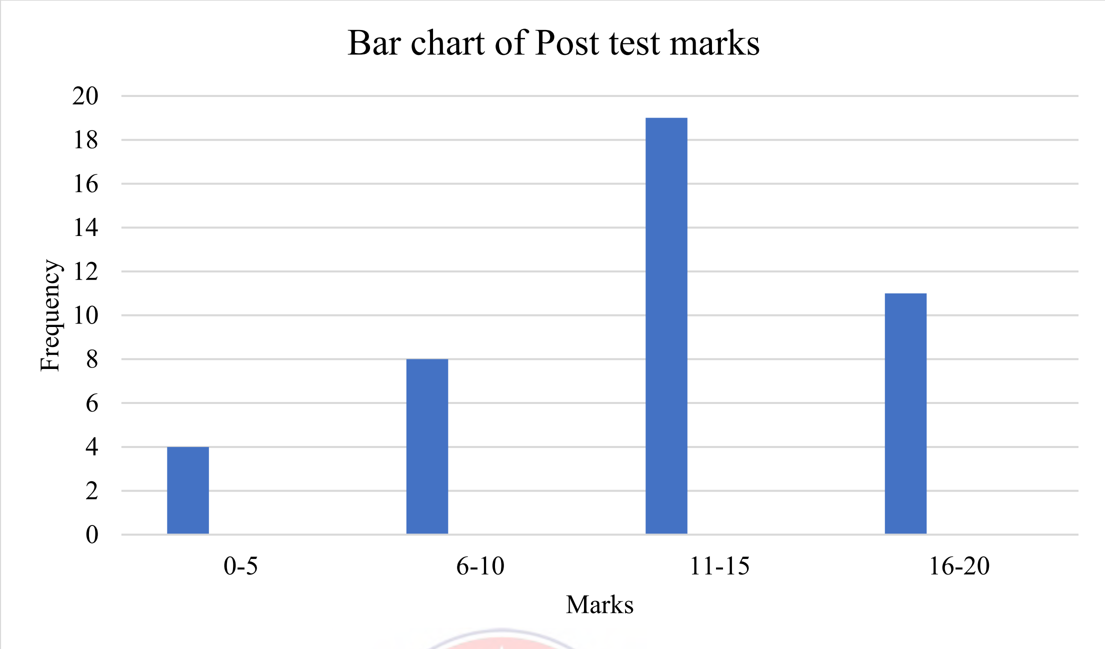


Figure 4.2: Graph of marks of Post-test of students

From the chart it was realized that there was a general increase of the number of students as the marks increases from 0 to 10 with a sharp increase from 8 students to 19 students obtaining 6-10 to 11-15 marks. Even though there was a drop as the marks increased from 11-15 to 16-20 that is, 19 students to 11 students the performance was not bad.

Table 4.4: The post intervention marks of form 2B1

Marks	Number of students		Marks interpretation
	Pre test	Post test	
0-5	30	4	Low marks
6-10	10	8	Below average
11-15	2	19	Average marks
16-20	0	11	High marks
	42	100	

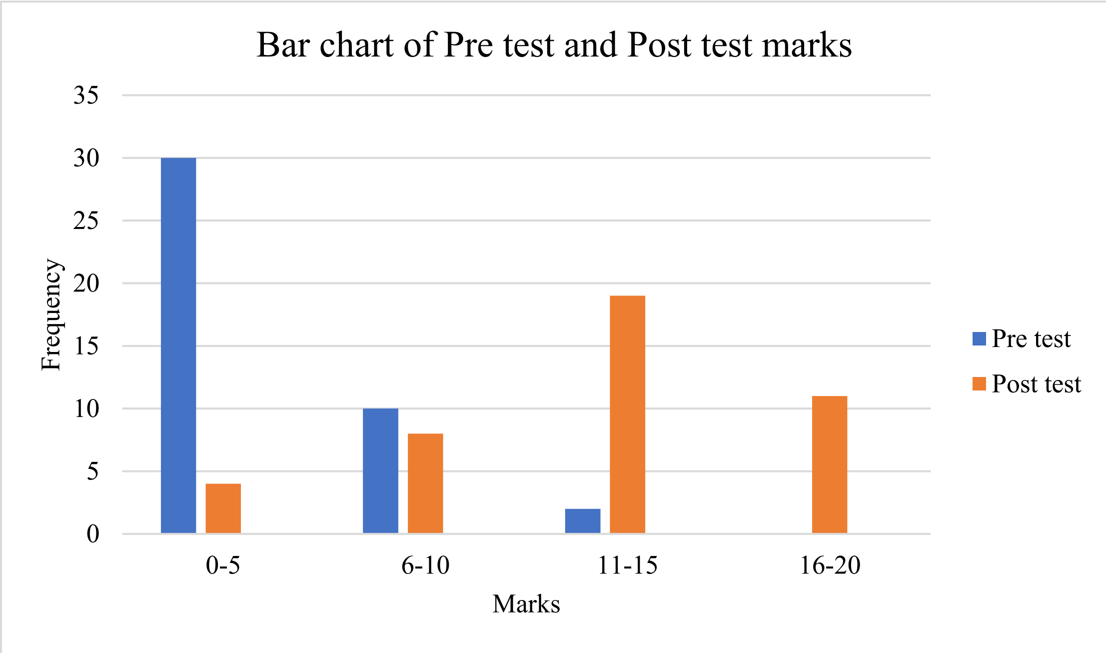


Figure 4.3: Graph of both pre-test and post-test

From the chart it is realized that there is a general increase in performance of students during the Post-test than the Pre-test. Whiles there is a sharp decrease in the number of students from 30 to 2 as the marks increases from 0 to 15, there is a sharp increase of the number of students from 4 to 19 as the marks increases from 0 to 15. It is also realized that as more than half the number of students (30) had marks from 0 to 5 in the pre-test whiles only 4 students had 0 to 5 marks in the Post test which indicated a drastic improvement in the performance.

Table 4.5: Analysis of Pre intervention and post intervention marks of form 2B1 paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test	3.76	42	3.267	.504
	Post-test	12.50	42	4.369	.674

*** Paired samples statistics is significant at the .05 level (2 -tailed)

Paired Samples Test

		Paired Differences Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre-test – Post-test	-8.738	2.724	.420	-9.587	-7.889	-20.793	41	.000

From Table 4.5, it was realized that the mean of the Post-Test (test after intervention) for form 2B1 Class recorded 12.50 with a standard deviation of 4.37 which is far better than the Pre-test of the same form 2B1 class which recorded a mean of 3.76 with a standard deviation of 3.27. Thus, from the paired samples test $t(41) = 20.79, p \leq .05$ but $p = 0.00$ hence $t(41) = 20.79, 0.00 \leq .05$.

Hence the two, mean marks give a clear indication that there exists a statistically significant difference in the usage of constructivist approach (Post-Test) compared to the lecture method (Pre-Test), we therefore reject the null hypothesis that there is no statistically difference in students' performance and accept the alternate hypothesis. Thus, the constructivist method is more preferable than the lecture method.

4.3 Discussion of Results of the Research Questions

4.3.1 Research question one

To what extent does, constructivist approach of teaching and learning enhance students' knowledge in area of quadrilaterals?

The first research question sought to find out the extent to which constructivist approach of teaching and learning enhances students' knowledge in area of quadrilaterals. After the intervention, students admitted that area is not the same as perimeter. Also knowing the type of quadrilateral, you are dealing with helps to know how to find the area.

By observation, the researcher prior to the exposure of the student to constructivist approach, students could not differentiate between the different types of quadrilaterals. Thus, they consider all the shape of the different type of quadrilaterals the same and mostly calculates the perimeter instead of the area of the object. However, after using the constructivist approach, it was easy for the student to now identify the various types of quadrilaterals and applied the appropriate formula to compute the area. The result of this is supported with the pre-test and post-test results of the students are shown in bar chart below. These results suggests that the student's level of conceptual understanding of the area of quadrilateral after their exposure to the constructivist approach improved significantly. Thus, the student better understood the concept of area of quadrilateral better using the constructivist approach compared to the lecture method.

4.3.2 Research question two

To what extent does, the use of constructivist approach of teaching and learning enhance the performance of students in area of quadrilaterals?

To address the second research question the overall performance of the student before and after their exposure to the constructivist approach was used. Fig 4.4 below summaries the results.

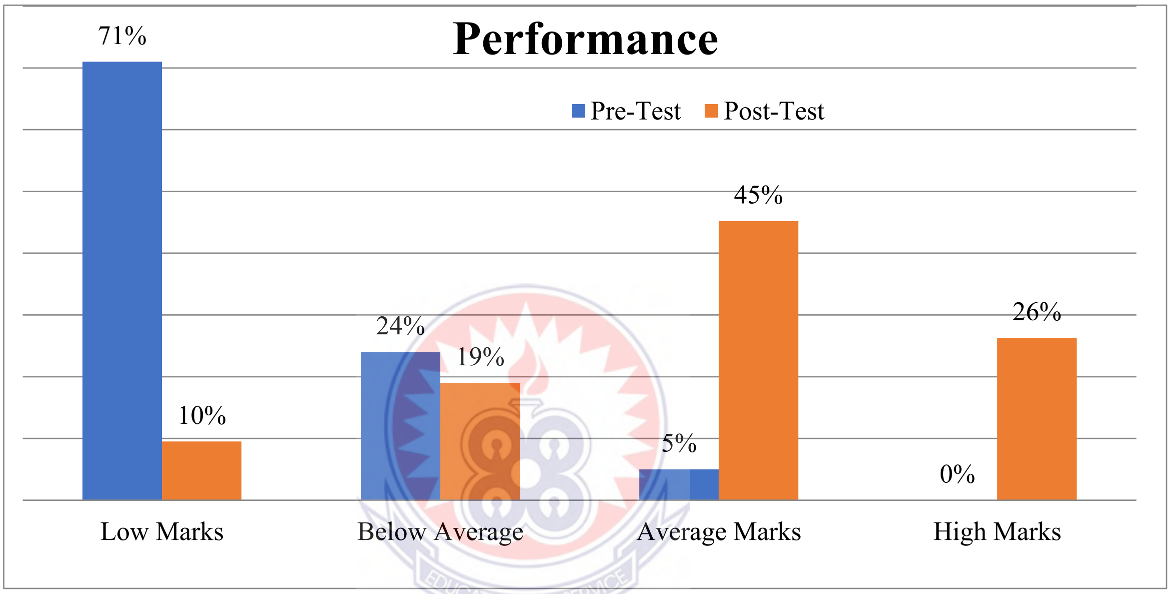


Figure 4.4: Graph of performance of students

From the chart, it is realized that performance in the pre-test drops as marks increase but the number of students increased as marks increases. 71% of students had marks 0-5 (out of 30), low marks in the pre-test whiles only 10% had low marks (0-5) in the post test. Furthermore, whiles no student scored marks from 16-20 during the pre-test, 26% of the students scored marks from 16-20 for the post-Test. Also 95% of the number of had marks below average and low marks (0-10) in the pre-test with 29% of students scored marks from 0-10 (below average and low marks) in the post test. This indicates that there was an improvement in the overall performance of students in the concept of area of quadrilaterals after the use of constructivist approach.

4.3.3 Research question three

How do students apply the concept of area of quadrilaterals in solving related problems area?

Students initially take any four-sided shape as having length and width therefore always get it wrong in finding the area of the object or shape. After the intervention (constructivist approach), they have realized the differences in the shape and therefore considers the shape before finding the area.

Again, the students use to find the perimeter instead of area, but with the intervention and understanding of the concept of area they now use the appropriate method to find the area. With the understanding of the concept of area, students have come to the realization that area of objects and shapes all depend on the space it occupies on the ground (shape of the base).

Again, after the introduction of the constructivist approach to students, they are able to find area of quadrilaterals with indent.

Finally, students are able to use this idea to find the area of other shapes other than quadrilaterals.

4.4 How Feasible is the Use of Constructive Approach of Teaching and Learning of Area of Quadrilaterals in S.H.S?

Piaget (1976) argued that young children construct their own understanding of the world through "doing" rather than 'hearing about it" (p. 17). Students at this level are not exempted from this, and so the use of constructivist approach which is learner centred and activity base prove to be one of the most appropriate methods in teaching at the senior high school.

It was realized that after the use of constructivist approach of teaching and learning (intervention) students understood the concept of area of quadrilaterals better with the constructivist approach.

Even though there were some challenges, like the few introverts were not cooperating well with colleagues and it was a bit difficult for few to grasp the concept taught with the activities, the constructivist approach proved to enhance understanding and performance of most of the participated students and it is therefore feasible to use the constructivist approach to teach in the senior high school.

4.5 Testing magnitude of impact intervention

The researcher wanted to find out whether or not there is statistically significant difference in students pre-test and post-test using constructivist approach of teaching and learning. This was done using the eta square to find out the magnitude of positive change in the mean of both the pre-test and post-test.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test	3.76	42	3.267	.504
	Post-test	12.50	42	4.369	.674

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-test – Post-test	-8.738	2.724	.420	-9.587	-7.889	-20.793	41	.000

A paired samples t-test was conducted to evaluate the impact of the constructivist approach on students' performance. The results showed a significant increase in the marks of students' pre-test (M=3.76, SD= 3.267) to post- test (M=12.50, SD=4.369), *t* (41) = -20.793, *p*= .000 (two tailed). The mean increase in the test scores was 8.738 with a 95% confidence interval ranging from -9.587 to -7889.

Thus $t(41) = -20.793, p \leq .05$ but the $p = 0.00$, hence $t(41) = -20.793, 0.00 \leq .05$.

Magnitude of effect size

$$\text{Eta square} = \frac{t^2}{t^2 + (N-1)}$$

$$= \frac{(-20.793)^2}{(-20.703)^2 + (42-1)}$$

$$= \frac{432.348849}{432.348849+41}$$

$$= \frac{432.348849}{473.3348849}$$

$$= 0.91$$

Cohen (1988), given eta square statistic (0.91) from the analysis indicated a large effect with substantial difference in the test scores obtained before and after the intervention, therefore constructivist approach improved performance of form 2B1 students of Nifa senior high school.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The primary objective of this thesis was to assess how the use of constructivist approach of teaching and learning can improve performance of senior high students specifically in relation to the concept of area of quadrilaterals. Additionally, the research sought to make the understanding of the concept of area of quadrilaterals easy and friendly for form two students of Nifa senior high school.

In view of the purposive study, the sample population of the students of Nifa senior high is 42. Based on the literature review, data from the interventions were distributed and the results analysed, the four main objectives of the study have been achieved.

The findings collected from the study are concluded in this chapter. Where prudent, recommendations with regards to the issues highlighted are also offered, with the hope that these might be useful and meaningful to the Mathematics Departments in all the senior high schools.

The findings revealed that constructivist approach facilitates the classroom activity and enhances its productivity and provides students the opportunity to explore. At the same time the teacher’s role remains central and essential in the classroom practice. The teacher’s role is based on identifying appropriate learning outcomes, choosing appropriate, structuring and teaching and learning materials sequencing the learning process. Issues concerning training for teachers, thus professional development in the form of in-service training courses for students needs to be adopted. Teachers need to be informed on how to effectively integrate more student-centered activities into mathematics teaching.

5.1 Summary of Findings

The results presented in this thesis was data collected from two students of Nifa Senior High School students specifically students in form 2B1. A total of 42 students in the class participated in the study representing a 100% participation rate. The study was done in two phases, the first phase was called the pre-test where students were taught the concept of area of quadrilateral using the lecture method of teaching and learning after which their performance was assessed using a test. The second phase saw the student being taught the concept of area of quadrilateral using the constructivist approach and tested again to assess their performance as well after being exposed to the constructivist approach.

In terms of the performance, the results showed that majority of the students (40 out of 42) scored lower marks (below average and low) during the pre-test phase and whiles for the post test phase, 12 out of 42 students had below average and 30 students got average and high marks. The results generally indicated that, the constructivist approach made the students grasped a better understanding of the topic after being exposed to the various constructivist approach activities. The positive comments given by the students after the use of constructivist approach confirmed that the constructivist approach in the teaching of area of quadrilaterals creates opportunity for students to be involved directly in the learning process and therefore enhances understanding.

5.1.1 Objective one: To examine student's geometric knowledge of mathematical concepts in area quadrilaterals using constructivist approach of teaching and learning

Based on the research findings, it is observed that in the pre-test and post test conducted, the constructivist method was more understandable to students and proved a significant outcome compared to the Lecture method. It was again, observed that students could visualize the shape of object, relate it to the question and apply the appropriate formula. It was also observed that students were able to identify the various quadrilateral shapes of objects around with ease.

5.1.2 Objective 2: To examine in-depth understanding of the concept of area of quadrilaterals using constructivist approach

The study revealed that students understanding of area of quadrilaterals was better after exposed to constructivist approach. They were not confusing the perimeter of a quadrilateral o the area but rather had the concept of area begin the space occupied by the shape or base of the object. The study revealed that, comparing the lecture method of learning of the concept of area of quadrilateral to the constructivist approach, the students significantly understood the concept better under the constructivist approach. Thus, students understanding of the concept is more enhanced using the constructivist approach compared to the traditional approach. This result therefore supported the hypothesis that; "There is statistically significant difference in students' performance (pre-test and post-test) using constructivist approach of teaching and learning.

5.1.3 To determine how students apply the knowledge acquired in the concept of area of quadrilaterals in solving related problems in area?

Again, the study investigated how students apply the concept of area of quadrilaterals in solving related problems area which was the third research question earmarked for the study. The third research question was assessed using an observational approach. The results revealed that the students understanding of re-allotment was connect to the concept of area in the sense that students were able to; measure the sides of quadrilaterals and noted them down, cut and re-arrange other shapes to form a square or rectangle, use unit squares to find area of quadrilaterals, use the concepts of re-allotment to find the area of quadrilaterals, and identify that in re-allotment, area is conserved whiles the perimeter changes. Furthermore students could easily relate area of quadrilaterals learnt to area of other shapes with the understanding of the concept of area.

5.1.4 How feasible is the use of constructive approach of teaching and learning of area of quadrilaterals in Senior high school?

The penultimate research objective was aimed at assessing how feasible the use of constructive approach of teaching and learning of area of quadrilaterals in S.H.S? This was analysed using qualitative approach. The results from the study revealed that, majority of the students learned more using the constructivist approach than the lecture approach. This was because, the constructivist learning approach encourages working in groups which makes the students enjoy as a result of everyone getting actively involved rather than being a passive learner and this make them enjoy learning and hence want to learn more. Additionally, the constructivist approach makes them remember well what they have worked on together rather than what they have memorized. The results corroborate studies such as (Akinbobola, 2006;

Gallenstein, 2004; Mayer, 2003; Omwirhiren, 2002) who all concluded that with constructivist approach, students are actively involved so they can actually do mathematics and not just being taught about mathematics.

5.2 Limitations of the Study

The major limitation of the research is due to the academic calendar and scheme of work scheduled for class; it was difficult for researcher to do anything outside the scheme.

Some basic restrictions of the research are that it is a single instrumental case study performed by one researcher over a small period of time. The study occurred in a particular time and under particular circumstances. The results could have been more reliable and contingent if research was carried out in more of the secondary schools and results analysed and generalised.

Although these findings cannot be generalized to the overall population, because of the small number of research units, according to Yin (2003) they can generalize theoretical propositions and this was the aim of this study.

Findings about students during class

The researcher was pleased with the results of constructivist learning in the classroom with rich conversations that went on in the classroom and the sharing that took place between students. The students were eager to share ideas within small groups, when they might have been hesitant in front of the entire class. By sharing ideas with each other first, they were able to use their own ideas and the ideas of their peers when asked to present to the entire class. As a final thought, teachers may feel compelled to assist students when they struggle with the right answers. In a constructivist classroom, teachers should allow students to work through their struggles. In this sense, teachers should take the advice of educators who focus on teaching with understanding. As Hiebert et al. (2002) write, "Many teachers worry that if they do not step in when a wrong answer is given or a flawed method is presented, students will be led astray and develop misunderstandings" p. 14. Yet, as he asserts, these fears are unfounded. "Our experience is if the tasks are appropriately challenging, that is, if they link up with students' thinking and allow students to use familiar tools, and if there is full discussion of various methods and solutions by the students after they have completed the task, then sound mathematical thinking and correct solutions eventually carry the day." It may be difficult for teachers to give up the spotlight in their classrooms, but to achieve understanding it is important to give students control of their learning. The researcher also witnessed students correcting their own mistakes and the mistakes of others in the classroom. The students achieved this by collaborating and reflecting on the thoughts and discoveries shared in the classroom.

5.3 Recommendations

5.3.1 Recommendation to Ministry of Education

The Ministry of Education is the parent ministry that takes care of the education sector. That is why it should be responsible for education indicators. It is recommended that:

1. The ministry should frequently organize in-service training for mathematics teachers to be abrase with hands on activities connected to the topics in the syllabus.
2. There should be fund allocation for teaching learning materials to support teachers.

5.3.2 Recommendation to all senior high schools in Ghana.

It is recommended that:

1. Mathematics teachers in all the various senior high schools should frequently engage in peer teaching to enhance mastery of the topics.
2. Mathematics teachers should research on topics well before teaching in order to be able to work within time frame.
3. The enrolment (class size) in the classes should be checked by school authorities so to enhance activity work and group work in the various classrooms.
4. Headmasters/mistresses and heads of mathematics department at Nifa SHS and other senior high schools should encourage and reward mathematics teachers who are implementing activity base teaching methods in teaching mathematics.

From the findings, it can be concluded that the constructivist approach might not be beneficial to every student. However, majority of the students would benefit academically if constructivist approach is implemented in the classroom. It can enhance achievement in mathematics in class as well as maximize the performance of students in the mathematics subject.

5.4 Suggestion for Further Studies

The researcher conducted the study in in the Nifa Senior High School specifically among Form 2 students. It is being suggested that a similar study be carried out on the use of constructivist approach of teaching and learning mathematics in all Senior High Schools in the Okere District in the Eastern Region of Ghana to encourage practical teaching and learning of mathematics as well as a comprehensive research document would be presented.

Additionally, the study focused on just the concept of area of quadrilaterals, the researcher further suggests that similar studies should focus on other geometry concepts or even other aspects of mathematics.

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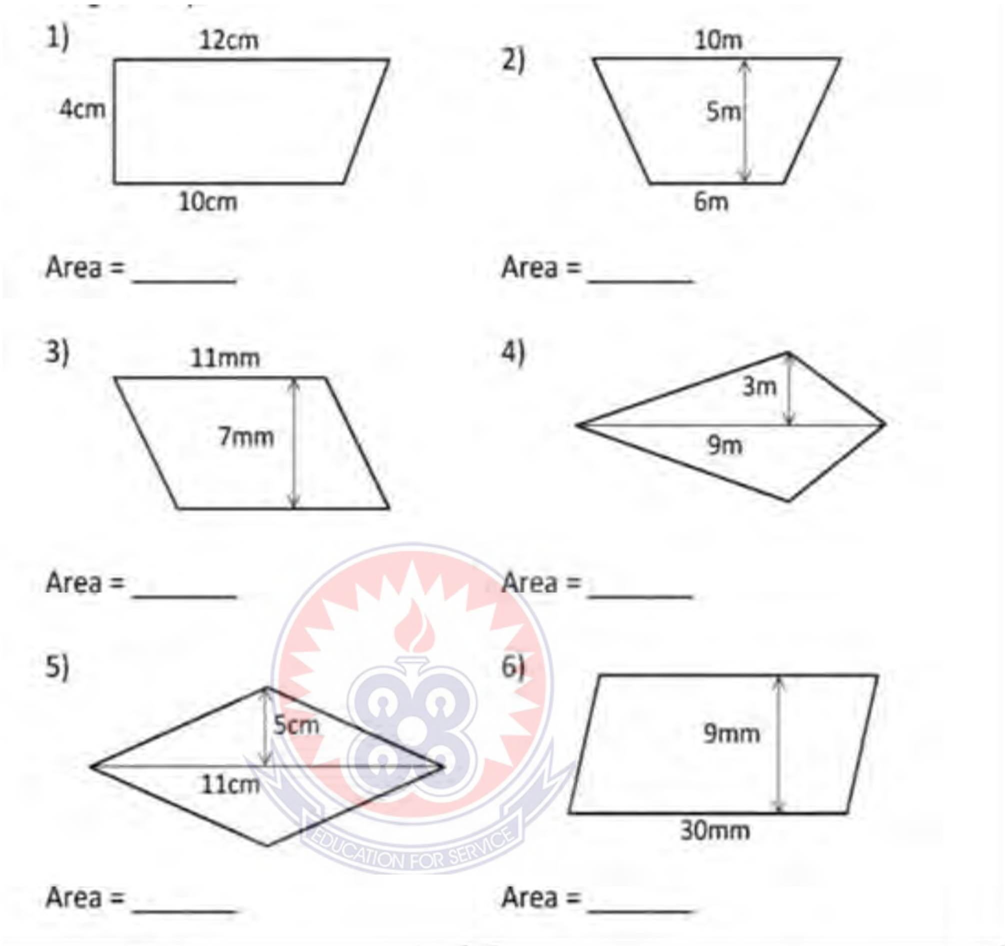
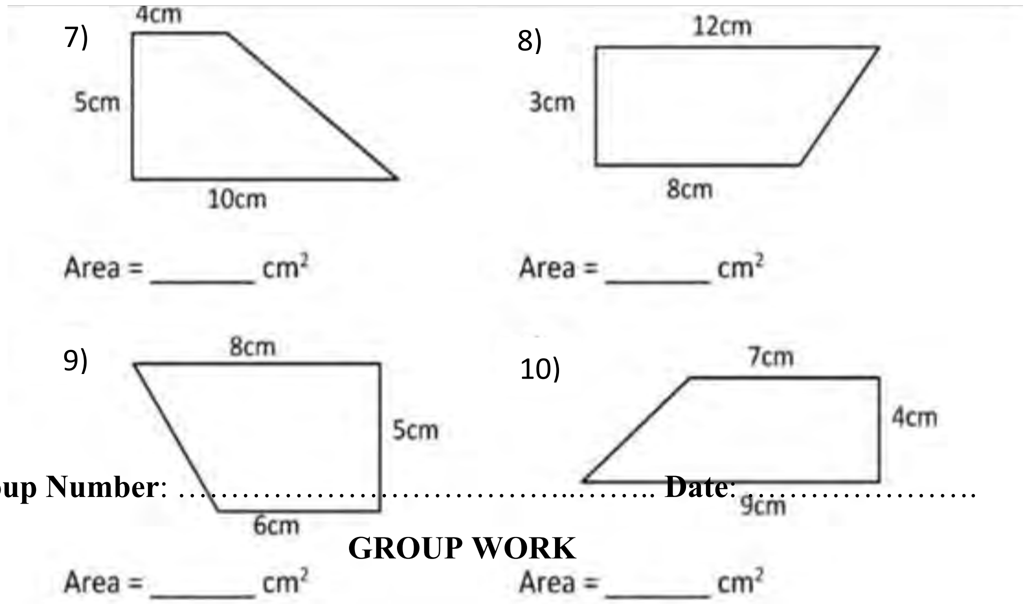
APPENDICES

Name: ………………………………………………..…….. **Date**: ………………….

TEST 1



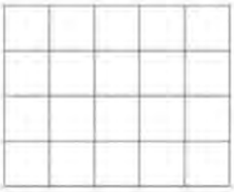


Group Number: ………………………………………………..…….. **Date**: ………………….

GROUP WORK

Work out the area of the following rectangles:

1)



Area = ________ square cm

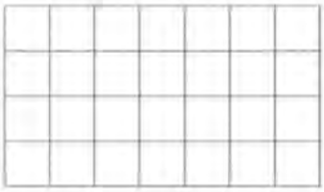
2)

Area = ________ square cm

3)

Area = ________ square cm

4)

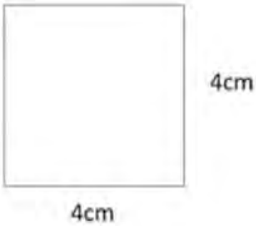


Area = ________ square cm

5)

Area = ________ square cm

6)



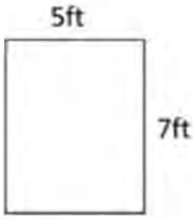
Area = ________ square cm

Work out the area of the following rectangles. They are not to scale.

1)

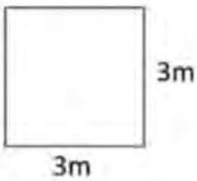
Area = ________ square cm

2)

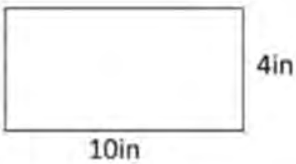


Area = ________ square ft

3)



4)

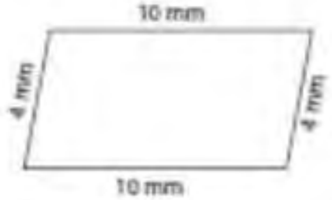


Name: …………………………………………………..…….. **Date**: ………………….

TEST 2

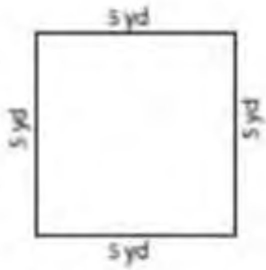
Find the area of each of the quadrilateral

1)



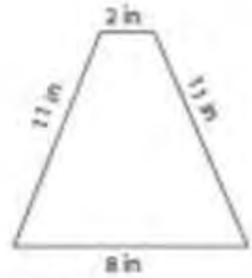
Area=_______________

2)



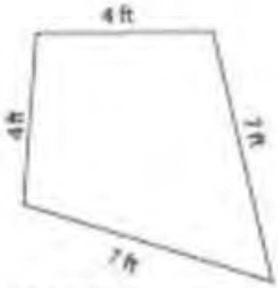
Area=_______________

3)



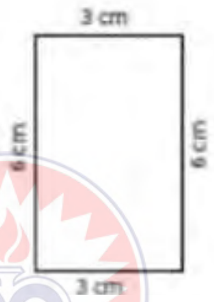
Area=_______________

4)



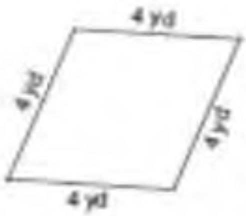
Area=_______________

5)



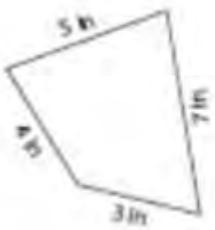
Area=_______________

6)



Area=_______________

7)

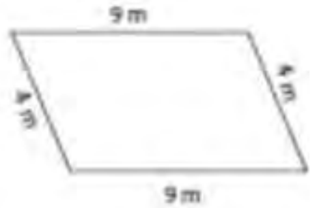


Area=_______________

8)

Area=_______________

9)

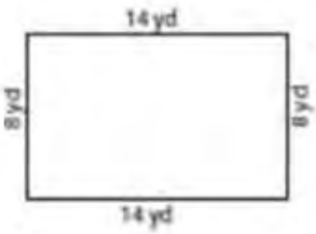


Area=_______________

0)

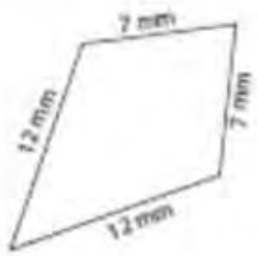
Area=_______________

11)



Area=_______________

12)

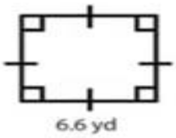


Area=_______________

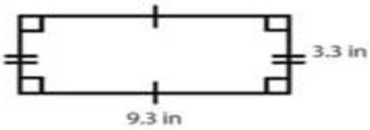
Name: ……………………………………………...…….. **Date**: ………………….

TEST 3 (Post-Test)

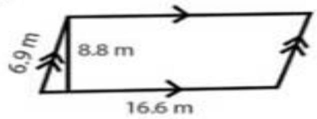
Find the area of each of the quadrilateral

1


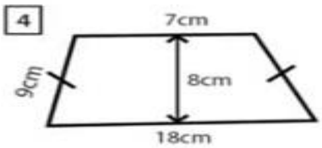
Area = ______

2


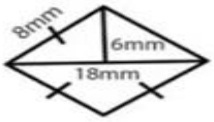
Area = ______

3


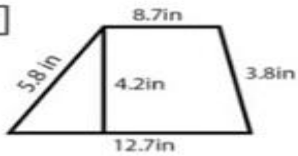
Area = ______

4


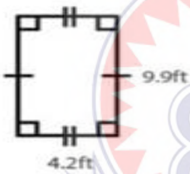
Area = ______

5


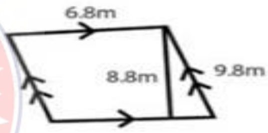
Area = ______

6


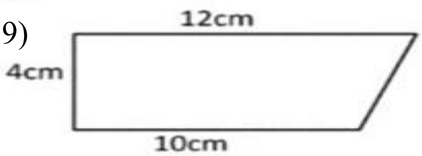
Area = ______

7


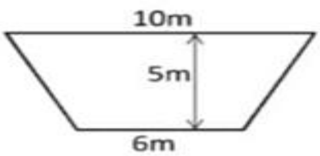
Area = ______

8


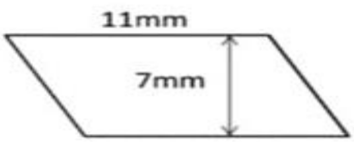
Area = ______

9)


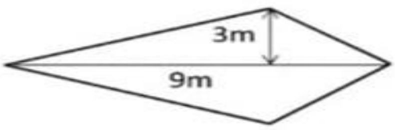
Area = ________

10)


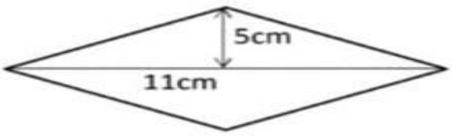
Area = ________

11)


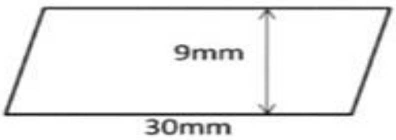
Area = ________

12)


Area = ________

13)


Area = ________

14)


Area = ________