EFFECT OF GUIDED-DISCOVERY AND PROBLEM-SOLVING STRATEGIES ON ATTITUDE AND PERFORMANCE TOWARDS GEOMETRY AMONG JUNIOR SECONDARY SCHOOL STUDENTS IN KADUNA STATE, NIGERIA.

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Being a Dissertation Submitted to the School of Postgraduate Studies, Ahmadu Bello University, In Partial Fulfillment for the Award of Master Degree in Mathematics Education, Department of Science Education, Faculty of Education Ahmadu Bello University, Zaria.

DECEMBER, 2015

DECLARATION

I declare that this thesis entitled "Effects of Guided Discovery and Problem Solving Strategies on Geometric Performance and Attitude of Junior Secondary School students in Kaduna state" conducted by me in the Department of Science Education under the supervision of Prof. Y.K. Kajuru and Dr. M.O Ibrahim.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of the thesis was directly presented for another degree or diploma at any University.

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Date

CERTIFICATION

This thesis entitled "Effects of Guided Discovery and Problem Solving Strategies on Geometric Performance and Attitude of Junior Secondary School students in Kaduna state" by Julie, MAIKUDU , meets the regulation governing the award of the degree of masters in Mathematics Education of Ahmadu Bello University, Zaria, and is approved for its contribution to the knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my husband Pastor Maikudi Ibrahim and children Hassan, Husseini and Rahamah.

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I thank the Almighty God, who by His grace saw me through the completion of this study. My special thanks to my able and efficient supervisors Prof. Y.K. Kajuru and Dr. M.O. Ibrahim who contributed to the success of this project through their patience, guidance, remark, tolerance, co-operation, accommodation and the fatherly advice in going through the whole manuscript. I am also grateful to Dr (Mrs) S.B. Olorukooba the PG Coordinator, Dr. Mamman Musa Head of Department Science Education, Dr. S.S. Bichi, Prof. C. Bolaji, Prof. I.A. Usman and other staff of the Department of who played vital toil the completion of this work. I appreciate the assistance given to me by staff of Mathematics Department, Ahmadu Bello University, and the management of Education Board, Zaria.

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ABSTRACT

This study investigated the effect of Problem Solving and Guided Discovery instructional strategies on JSS Students performance and attitude in Kaduna state. A qausi-experiment with pretest-posttest control group design adopted the 3x2 factorial analysis was employed for variable matching. The sample consisted of 381 Government JSS II students made of 195 males and 186 female students drawn from a population of six thousand four hundred and thirty one students of GJSS using stratified random sampling by balloting in thirty (30) junior secondary schools in Kaduna state. The research instruments used were: Geometry Performance Test (GPT) and Students Geometry Attitude Questionnaires (SGAQ). These instruments were validated and reliability coefficient estimated as r=0.98 and r=0.86 respectively. The five hypotheses were tested and analyzed using t-test ANOVA, ANCOVA and Kruskal Wallis Statistics. Post Hoc Scheffe and Least Significant Difference (LSD) were used to detect the source, magnitude and direction of such significant variations. All hypotheses were tested at $P \leq 0.05$ level of significance. The findings showed that: (1) there is significant difference among three groups of students when exposed to Problem Solving, Guided Discovery and Lecture Method (ii) there is significant difference in performance between male and female student when exposed to problem solving, guided discovery and those expose to lecture method. (iii) significant difference exist among the three groups in mean attitude score toward geometry when exposed to problem solving, guided discovery instructional strategies and those taught using lecture method . (iv) There is significant mean difference between male and female attitude towards geometry when exposed to problems solving, guided discovery and those in lecture method. Based on this finding, it is recommended that problems solving instructional strategy should be adopted in teaching the JSS student because this strategy produced higher mean score in performance among the students. This implies that mathematics teachers should be trained through seminars and workshops on how to effectively design and use the problem solving and guided discovery strategies in teaching geometric concepts. Conclusively, the problem solving and guided discovery strategies are viable alternatives to the lecture method particularly in teaching abstract geometric concepts among the JSS students.

OPERATIONAL DEFINITION OF TERMS

Academic Performance; a measure of what a person has accomplished after exposure to an educational programme.

Attitude; is the tendency which the students expressed, feel or think and act positively or negatively toward geometric concepts when exposed to guided-discovery or problem-solving strategies.

Discovery method; is a technique that encourages students to take a more active role in their learning processes, by answering a series of questions or solving problems.

Gender is defined as the amount of masculinity and feminity found in a person.

Lecture method; is a pedagogical strategy in which a lecturer presents his lesson to a large number of students verbally but with little participation from the students.

Performance; The ability of students to score significantly high in the Geometry achievement test.

Problem solving strategy; Is a teaching approach that comprises action steps to be taken by the leaner to reach anticipated goal when faced with a problem situation with the guidance of a teacher.

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CHAPTER ONE

THE PROBLEM

1.1 Introduction

Education is a systematic training and instruction designed to transmit knowledge and develop skills in individuals. This involves a continuing development of relevant knowledge, skills and habit whose broad understanding and application enable individual to contribute meaningfully towards the growth of their society (Mbah, 2012). It is believed that the quality of a nation's education is proportional to the level of its prosperity. Nigeria having realized the effectiveness of education as a powerful instrument for national progress and development, adjusted her educational philosophy and methodology to march the ideals and challenges of charging economics and social structure of modern society (FME, 2013). The policy is geared towards producing individuals who will not only possess the capability to solve his problems but also contribute to the development of his society. A number of several subjects can be identified in the curriculum of schools at all levels of Nigerian education, the subjects are included with the expectation that when properly taught, a more effective learning will be the result and this will bring about realization of the goal of Nigerian education as stated in the National Policy on Education (Oche,2012).

There are certain subjects that are classified as core subjects, while others are known as electives (FME, 2013). Core subjects are those subjects which students compulsorily offer while electives subjects consists of subjects from which students can freely make their choice. At the junior secondary school level, Mathematics is a core subject which should be taught well. This is because; the concept of Mathematics plays an important role to an individual day-to-day life and also to the nation at large.

Mathematics is a leading logical science upon which other science depends. Mathematics can be defined as the communication system for the concepts of shapes, size, quantity and order used to describe diverse phenomena both in physical and economic situation. Mathematics is a tool use in science, technology and industries. The definition connotes that all sciences draw their aspirations from Mathematics and in fact implies that Mathematics is a language of sciences. Ezeugo and Agwagah (2000), in their study looked at Mathematics as a scientific tool in realizing the nation scientific and technological aspirations. Also Usman (2002) considered Mathematics as a subject that encroaches into all aspects of human endeavor and further describe Mathematics as the life wire in the studies of various disciplines. It is this importance of Mathematics that compelled the Federal Government of Nigeria to make Mathematics a compulsory subject from the primary school through to the end of the senior secondary school education. However, literature reviews constantly the low performance of students at all levels of education in the subject (Suleiman, 2010; Serkan 2011; Hassan, 2014, Bello, 2014; Adamu, 2014). Other reports on the same subject matter have over the years indicated poor academic performance and general negative attitudes of students towards the subject (Tali, 2012; Sherax, 2014; Jackson and Martins 2014).

Geometry contributes immensely to helping students develop the skills of critical thinking, problem-solving ability, conjecturing, deductive reasoning, logical argument and proof. Geometric representation can be used to help students make sense of other areas of Mathematics.

Geometry is an important source of Mathematical thinking. It helps to sharpen man's intuition and ability to think logically as well as kindle his interest in observations. It comprises of theories and logical proofs which could be very interesting if well understood.

To stress on the importance of teaching geometric concepts effectively, Ogunkunle (2000) opined:

"Geometry is supposed to assist students to:

- Clarify and enlarge their store of concepts
- Aid in the use of geometric instruments
- Acquaint students with good geometrical notations
- Develop insight into analogous properties
- Systemize the initial geometric information and extends its application in everyday life (page 87-88 paragraph 4"

Geometry constitutes 38% of the Mathematics curriculum and it is the worst performed topic in all Nigerian external and internal examinations making the overall subject performance very poor (Tsoho, 2011). Since geometry involves a lot of applications to real world situations and proofs, it is problem solving strategy or guided discovery method that can best handle the difficult and challenging concepts. As a review of the teaching and learning methodology, this study investigated the effect, if any, of problem solving strategy and guided discovery on students' performance and attitude in geometry. As a result, geometry was used in this study as a topic which poses the greatest challenge to students and its application of the six levels of cognitive domain; knowledge, comprehension, application, analysis synthesis and evaluation.

Universal Basic Education (UBE) was a reformed program in Nigeria's Basic Education (from primary one through JSS 3) and is to reinforce the implementation of the National Policy on Education , in order to provide greater access and ensure quality throughout the federation as

it is free and compulsory (Adomeh, Arhedo & Omoike 2007). Importantly, Nigeria adopted UBE as a process of fulfilling the aim of Education for All (EFA) as endorsed at the world conference on education held in Jomtien in 1990. According to the conference, basic education is made free and available to all sundry, thus emphasizing free access, equality, efficiency, literacy, numeracy and lifelong skills for all (Sherax 2014). There exist a number of teaching methods available for teachers to use and they include lecture method, discussion method, demonstration method, discovery method, laboratory method, and problem solving methods to mention just a few. This study compares two methods (Guided-discovery and Problem solving) of teaching Mathematics with a view to determining which of them will be more effective and will result in better learning and greater performance through which the teaching of geometry at junior secondary schools in Kaduna State may be improved.

A teaching method whereby the student is featured as the active participant, where the teacher assumes the roles of a facilitator, mediator and assessor of learning have been found to be superior in developing students' abilities in applying concepts and personal growth, developing positive attitudes, fostering motivation, and encouraging appropriate group social skills (Welbery, 2009). An approach of instruct through which students interact with their environment by exploring and manipulating object is regarded as discovery teaching (Ormrod, 2000). Discovery teaching has been described as a process of allowing the student to take the leading role in his own learning experience. This method encourages students to actively use their intuition, imagination, and creativity because the method starts with the specific and moves to the general. The teacher presents examples and the students work with the examples until they discover the interrelationships. Bruner (1961) believes that classroom learning should take place through inductive reasoning, that is, by using specific examples to formulate a general principle. For instance, if students are presented with enough examples of triangles and non-triangles, they

will eventually discover what the basic properties of triangles must be. The teacher therefore acts as a facilitator and guides, making it possible for the learner to reach mutually-agreed upon goals. The teacher serves as a resource person to stimulate, motivate, clarify and explain. The idea is that students are likely to remember concepts they discover on their own.

Problem solving is a method of teaching used to accomplish instructional goals of learning basic facts, concepts, and procedures, as well as goals for problem solving within problem context. This method encourages pupils or students to probe into a problem. In teaching Mathematics, problem solving strategy is characterized by interactions between students and teachers, Mathematical dialogue and consensus between students, teachers providing just enough information to establish background of the problems, and students clarifying, interpreting and attempting to construct one or more solution process, teachers accepting right or wrong answers in a non-evaluative way, teachers guiding, coaching, asking insightful questions and sharing in the process of solving problems, teachers knowing when it is appropriate to intervene, and when to step back and let the pupil or student make their own way (Lester et al; 1994).

The problem-solving and guided-discovery instructional techniques were considered in this study because it will give the researcher the insight on the extent to which each of the teaching techniques contributes to the performance and attitude of students in geometry. Based on this, the researcher is prompted to carry out a research to examine the impact of guided-discovery and problem-solving Mathematics instructional strategies on the performance and attitude of Junior Secondary School students in Kaduna State, Nigeria.

1.2 Statement of the Problem

This study was aimed at investigating whether Guided-discovery and Problem solving strategy will have any effect on attitude and performance towards geometry among JSS in Kaduna State. The motivation to conduct this research was based on the experience of the researcher who teaches under the Kaduna State Teaching Service Board for over a Decade and also participates in the coordination and marking of WAEC (Mathematics for both Junior and Senior) for over eight years and observed that students dodge away from attempting to answer questions relating to geometry. Also, Students attitude towards geometry in the Junior Secondary schools are generally decreasing that an urgent attention has to be considered by math's educator if geometry should continue to be a tool for national development. It was observed that poor performance has become prominent in geometry especially at basic Mathematics level and this may be due to the fact that traditional methods like Lecture, Rote learning and unguided discovery are being used by teachers (Kaura, 2014). In particular, West African Examination Council (WAEC) Examiners' report (2005 & 2013) reveals that students have problem with geometric areas of Mathematics and such problems have been traced to lack of essential rudiments of geometry at lower levels of education. The studies cited that students have difficulty to accurately measure, draw and construct and prove identities or use of formulae in geometry, virtually students suffer skills and abilities needed in geometry. Similarly, research findings on the newly admitted university students offering 100 levels Math and at basic level consistently indicates that geometry is one of the most difficult areas of mathematics (Adetula, 2005). Again, the researcher observed that students overall performance in JSS Mathematics placement Exam conducted annually in Kaduna State has generally been very poor and that students rarely or sometimes completely avoid attempting questions in geometry as shown in the following table

Table 1.1: Students' Performance in JSSCE Mathematics in Kaduna state from 2009-2013

Year	Total No. that sat for exam	No. of Students that Passed	% of students that passed	No. of students that failed	% of students that failed
2009	1153	120	10.41%	833	89.6%
2010	1129	114	10.09%	815	89.9%
2011	1036	103	9.94%	633	90.1%
2012	988	108	10.9%	317	89.5%
2013	890	110	9.7%	566	90.3%

Source: Kaduna state Ministry of Education (2014)

This failure rate may be due to poor method of teaching by some teachers which resulted to negative attitude by some students and lack of good instructional materials that could stimulate the interest of students which may lead to better understanding of the subject. Hence there is the need to develop a strategy that might enhance students' active participation, positive attitude and high academic performance in geometry such as the guided-discovery and problem solving strategies at Junior Secondary schools. Therefore, this study was set to investigate the effect of guided discovery and problem solving teaching strategies on students' attitude and academic performance towards geometry among Junior Secondary Schools in Kaduna state.

1.3 Objectives of the Study

The objectives of the study were to:-

1. determine the effects of guided discovery and problem solving strategies on JSS academic performance in geometry and those taught with lecture method
2. determine the effects of guided discovery and problem solving on students' attitudes towards learning of geometry and those taught with lecture method

3. examine the effect of guided discovery and problem solving instructional strategies on performance of students' with respect to gender in geometry and those taught with lecture method
4. investigate any difference in mean attitude score between male and female JSS students taught geometry using Problem-Solving and Guided-Discovery
5. investigate any difference in mean attitude score between male and female JSS students taught geometry using lecture method

1.4 Research Questions

The research work provided answers to the following research questions:-

1. What is the effect of guided-discovery and problem solving instructional strategies on geometry performance of students?
2. What is the effect of guided-discovery and problem solving instructional strategies on students' attitudes to geometry?
3. In what way would guided-discovery and problem solving instructional strategies affect students' performance with respect to gender?
4. What is the attitude of Male & Female JSS students towards the study of geometry when exposed to Problem Solving and Guided-Discovery strategies?
5. What is the attitude of Male and Female JSS students towards the Study of geometry when exposed to lecture method?

1.5 Null Hypotheses

The following null hypotheses were formulated and tested at the significant level of 0.05

H_{01}. There is no significance difference in the mean score of students' performance in Geometry among students exposed to guided discovery and problem solving teaching strategies and those taught with lecture method

H_{02}. There is no significant difference between students attitudes mean scores in geometry after exposure to guided-discovery and problem solving instructional strategies and those taught with lecture method

H_{03}. There is no significant difference in the mean score of male and female taught Geometry with guided-discovery and problem solving instructional strategies and those taught with lecture method

H_{04-} There is no significance difference between male and female JSS students; attitude toward geometry when exposed to Problem-Solving and Guided-Discovery instructional strategies

H_{05-} There is no significance difference between male and female JSS students; attitude toward geometry when exposed to only lecture method

1.6 Significance of the Study

Geometry is useful for day to day activities particularly in our homes and industries and also an important tool for science and technology development; hence the result is significant for the following reasons.

The study will help authors to advocate appropriate methods of teaching geometric concept in their textbooks in subsequent editions. The findings will help in improving further education, since more students will be able to read course of their choices. The finding will be useful for further researchers in Problem Solving and Guided Discovery instruction strategies,

performance and attitude as well as other theories of learning. The findings could be used to clarify, support or substantiate the existing learning theories expressed by other psychologist. It could contribute to the improvement of Mathematics teaching and learning at all levels of secondary schools. It could foster new approaches in curriculum and text development. It could help in actively involving the participation of students.

Also, Mathematics being the backbone of science and technology is a prerequisite for almost all engineering and other technological courses. It is therefore anticipated that the findings of this study would be valuable to various bodies/stakeholder that are likely to benefit from the outcome/result of the study, and those who are engaged in scientific and technological policy formulation, implementation and development in the country like: teachers, students, universities and colleges, National educational organization and curriculum developers.

In addition, the study will help teachers in the adaption of appropriate methods of teaching geometric concepts and problem solving skills. Teachers responsible for the teaching of Mathematics to secondary school students might utilize the finding in the secondary school classroom by:

1. Helping students to have conception shift in favor of geometric valid concept.
2. Taking into consideration, students prior knowledge and
3. Developing inexpensive modules that would enhance teaching, learning and assessing understanding of geometric concept.

Furthermore, it is hoped that the study would encourage students to be actively involved in the construction of knowledge and to take charge of their own learning. Active participation of student might help them to develop self-confidence and positive attitude toward Mathematics.

Additionally, institutions of higher learning where Mathematics teachers are trained would need to /incorporate the strategies to teaching learning. This would enable them produce more efficient teachers who would help student construct knowledge on their own. Bodies like Mathematical Association of Nigeria (MAN) Statistics Association of Nigeria (SAN), National Education Research and Development Council (NERDC) that carry out researches discuss and disseminate research findings, might wish to consider the result of the research with a view to using the strategies to promote geometric instruction in schools.

Again, the findings of the study would be useful to mathematics textbooks publishers as it will assist them in selecting materials and activity questions base exercises to be incorporated in the text that would promote academic performance and change attitude positively among learners.

Finally, poor attitude acquired at the foundation level could continue to hurt the learner at every level of education. This trend if left to continue, will in no small measure affect adversely the growing needs to have trained scientist, technicians, economist and people in other fields of profession, since all depends in one way or the other upon Mathematics. The findings of this study is hoped to change negative attitude towards geometric concept among secondary school students.

1.7 Scope/ Delimitation of the Study

This study concentrated on the effect of guided discovery and problem solving strategy for teaching geometry at JSS 2 in Kaduna State. Thus, the study was confined to only JSS 2 because they were the most stable at the time the research was carried out since JSS 1 were just being admitted and also JSS 3 were preparing for their final placement examinations. Also the concepts taught in geometry during this study included plane shapes, quadrilaterals, triangles and regular polygon at the confine of the JSS curriculum. These Concepts were chosen because

knowledge of them establishes the foundational background leading to geometrical concepts in the Senior Secondary Schools. The concept is also part of the JSS curriculum. These topics were selected for the purpose of this research because they involved concepts that required active participation by the students and teachers at JSS level during the teaching and learning process, with the assumption that they may sound a bit abstract to students at the Junior Secondary School level.

In addition, the geometry performance test was the instrument used consisting of 40 items with option A –E. Also the geometric concept questionnaire was used to find out attitude of student towards geometric concepts before and after the treatment.

1.8 Basic Assumptions

The following were the basic assumptions for the study. In carrying out this study it was assumed that;

a. The students used for the study have covered the Junior Secondary One Math Curriculum and were familiar with some Geometry concept
b. The students used for this study were not familiar with words like Problem-Solving and Guided-Discovery instructional strategies and their application as instructional strategies

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

The main purpose of this study was to investigate the effect of problem solving and guided discovery instructional strategy on JSS performance and attitude towards geometric concepts. The review enabled the researcher to know what previous investigations have found on topics relating to the present study.

For better organization and understanding the literature was reviewed under the following sub headings:

2.2 Conceptual Framework of the Study

2.3 The Concept of Guided-Discovery

2.4 The Concept of Problem Solving

2.5 Lecture Method of Teaching and Learning

2.6 Related Studies on Guided Discovery Strategy and Problem Solving Strategies Attitude and Performance

2.7 The Concept of Geometry

2.8 Secondary School Students' Attitude towards Geometric Concepts

2.9 Studies on Gender and Performance in Geometric Concepts

2.10 Overview of Related Studies

2.11 Implication of the Reviewed Literatures on the present study

2.2 Conceptual Framework

Mathematics teachers at all level generally agree that the teaching and learning of Mathematics must;

i. Extend the students way of thinking
ii. Develop students abilities in problem handling and solving; and
iii. Provide applicable Mathematics knowledge, expertise and skills for future needs.

Therefore, for learners to participate fully in Mathematical activities, with excitement, full understanding and apply it in their daily lives there is the need for good teaching strategies. These strategies are the type that should involve full participation of the learner. This point of view makes instructional strategies fundamental to any effective instruction. Teaching approach used by a teacher is very important to the success of learning. As a result teachers employ varying teaching strategies to accomplish their educational objective since no one method of instruction will work all of the time and under every circumstance.

It is however, important to note that the traditional or teacher centered strategy could be regarded as the hitherto existing conventional method of instruction in the normal classroom setting. There exist several of such conventional method which has permeated our educational system over the years. Among such are; lecture, demonstration, activity, discussion, inquiry, role play, role-learning, discovery, project, storytelling, dramatization, excursion and experimental/laboratory work among others. At any rate, any of the teaching strategies if properly planned can make learning a successful process Tsoho (2011). According to Tsoho (2011), what generally makes a specific teaching method student centered is the ability to involve students actively in the teaching process. As already mentioned, the intent of this research is to determine the effects of guided discovery and problem solving.

2.3 The Concept of Guided-Discovery

The guided discovery method is a teaching technique that assists learners in problem solving. The method is child-centered and activity oriented, thereby gives learners the opportunity to discover facts about a particular problem (Dike 2008, Getso, 2008, and Fajemidagba, 2013). Guided discovery or inquiry refers to a way of questioning, seeking knowledge or information or finding out about phenomena. It involves investigation, searching, defining a problem, formulating hypothesis (Sola and Ojo 2007). This method gives learner the opportunity to engage in exploitation and sense, making it Mathematics content (Gervey and Sgroi, 2003). It also gives students self direction to assimilate and accommodate information (Sola and Ojo, 2007).

Many researchers have worked extensively on discovery learning. Nwagbo (2006) revealed that it showed good performance in pupils than expository similarly, Abubakar and Dodboo (2011) explained it assisted learner to understand problem solving as they learn by experiment. The findings of Ibe (2006) on Guided discovery showed highest mean scores compared to demonstration and the least mean score in conventional.

In terms of gender difference in achievement male shows higher mean score than female. The guided discovery approach has effects on student performance and attitude (Mohammed 2012). In the study of Nwachukwu and Nwosu (2007) it was observed that the success of some known innovative and effective methods may be predicated on the level of exposure students have had in basic day-today method of discovery.

Guided discovery method of teaching is a technique that encourages students to take a more active role in their learning process, by answering a series of questions or solving problems. (Mayer 2003) added that discovery method is based on the notion that learning takes

place through classification and formation. This method was postulated by Brunner (1961). The method enables students to get experience in using facts and principles, processes by using mental processes and manipulating Mathematical materials.

In a study conducted by Fajemidagba (2013) to investigate the effect of guided-discovery learning strategy on students performance in Mathematics alongside influence of gender and scoring abilities of the secondary school students in Osun State, the findings revealed that all of the experimental group students exposed to guided-discovery performed significantly better than the control group students exposed to non-guided strategy. The finding of Fajemidagba agreed with those of Martins and Oyebanji's (2000) and Bajah and Asim (2002). Also in another study by Suleiman (2010) using the guided-discovery strategy reviews that both female and male students' acquisition of knowledge was beneficial equally.

Again Mankil (2006) investigated using demonstration and guided-discovery method in correcting misconception in physics amongst remedial student and revealed that the low scorers benefited least while taught using the guided-discovery strategy and the strategy benefited high.

Advantages of guided discovery teaching method

i. Increases intellectual attainment
ii. Shift of reward from extrinsic to intrinsic
iii. Valuable in the investigative process
iv. Helps memory processing of children

Disadvantages of guided-discovery teaching method

i. Slow and time consuming
ii. Not effective in large classes
iii. Pays little attention to the acquisition of organised body of knowledge and instructions.

In discovery learning, the teacher must carefully plan the questions which should be asked in order to help students to attain the principle or abstraction being taught, order the examples in the lesson, and be certain that the reference materials and equipment are readily available. However these preparations do not always guarantee success. In order to benefit from a discovery situation, students must have basic knowledge about the problem and must know how to apply problem-solving strategies. Without this knowledge and skill, they will flounder and grow frustrated.

Discovery learning encourages students to actively use their intuition, imagination, and creativity because the approach starts with the specific and moves to the general. The teacher presents examples and the students work with the examples until they discover the interrelationships. Bruner (1961) believes that classroom learning should take place through inductive reasoning, that is, by using specific examples to formulate a general principle for instance, if students are presented with enough examples of triangles and non-triangles, they will eventually discover what the basic properties of triangles must be.

Tomei (2003) stated that discovery learning can be implemented in the classroom as follows:

- Present both examples and non-examples of the concepts one is teaching.
- Help students see connections among concepts.
- Use diagrams, outlines, and summaries to point out conclusions
- Pose a question and let students toy to find the answer
- Encourage students to make intuitive guesses by administering following suggestions:

a) Instead of giving a word's definition, say "lets guess what it might mean by looking at the words around it".

b) Don't comment after the first few guesses. Wait for several ideas before giving the answer.

c) Using guided questions to focus students when their discovery has led them too far astray.

Habor (2000) pointed out that the guided discovery teaching approach is techno-scientifically oriented. It places the learner's constructive mental ability first in all instructional processes. In order words, it is learner centered.Also, the guided discovery teaching method effectiveness has been investigated in some aspects of sciences and Mathematics. For instance Nwagbo (2008) investigated it effectiveness in achievement an attitude in Biology, Allahoki (2012) investigated its effectiveness on achievement of high and low achievers in senior secondary school Biology, Confer (2000) on student's achievement in geometry which is an aspect of Mathematics and Ogwuche and Kurumeh (2010) conducted her investigation on senior secondary school one achievement in Algebra. In their respective studies the guided discovery teaching approach was found suitable and effective in teaching of those aspects of the science and Mathematics. Hence this studies would want to investigate the effect of problem-Solving and guided-Discovery on attitude and performance of JSS Students in Zaria

2.3.1 How to Use Guided Discovery Problems

Guided-discovery problems can be incorporated into lecture, lab, and field courses. They fit beautiful into the exploration phase of the learning cycle approach to teaching (Brown and Abell, 2007). Thus they work best when they are assigned before any lecture or readings on the topic. Because guided-discovery problems are time-consuming and foster deep learning, they are best used to teach course material that is especially important, conceptually difficult, or counterintuitive.

In order to succeed, a guided-discovery problem must be adequately scaffolded (Hogan and Pressley, 1997; Hmelo-Silver and others, 2007) so that students remain within their "zone of proximal development," the zone between what they can do on their own and what they can't do, even with help (Vygotsky, 1978). This scaffolding should be incorporated into:

- the written materials that the students receive,
- the interactions between the instructor and the students, and
- the interactions among the students.

There are a variety of methods for providing the necessary scaffolding, including the 3-step **Learning-for-Use** design framework consisting of motivation , knowledge construction, and knowledge organization (**Edelson and others, 2006**), and teacher-student conversations in which the teacher does not directly answer student questions but, instead, asks the students a series of questions that steer students in the right direction. These questions may invite students to explain what they already understand, clarify those explanations, provide the evidence and reasoning underlying their assertions, or see the holes in their arguments (Hogan and Pressley, 1997). This model is a useful guide in the instrumentation of the Guided Discovery instructional strategy

2.3.2 Creating Guided-Discovery Problems

Gerver and Sgroi (2003)describe eight critical steps necessary in developing successful guided-discovery problems. These steps are.

1. **Selecting the content:** Choose content that is new but derivable using skills and knowledge that the students already possess.
2. **Stating the aim:** Clearly state the objectives of the lesson without spoiling the "Aha!" component.

3. **Identifying the prerequisites:** Identify the knowledge and skills that students will need in order to successfully complete the problem. Then test to make sure the students have them.

In prior class sessions, students learn and repeatedly practice these skills. Testing of these skills is accomplished through student presentations and whole-class discussions. Note that prerequisite skills need not be highly developed; they can still be rudimentary, in which case the guided-discovery problem serves a dual role as both a way to learn new concepts and an opportunity to practice and improve previously acquired skills.

4. Setting up a graphic organizer: As you design the lesson, it is very helpful to make a schematic outline that reveals the flow and logic of the lesson as in the flow chart.

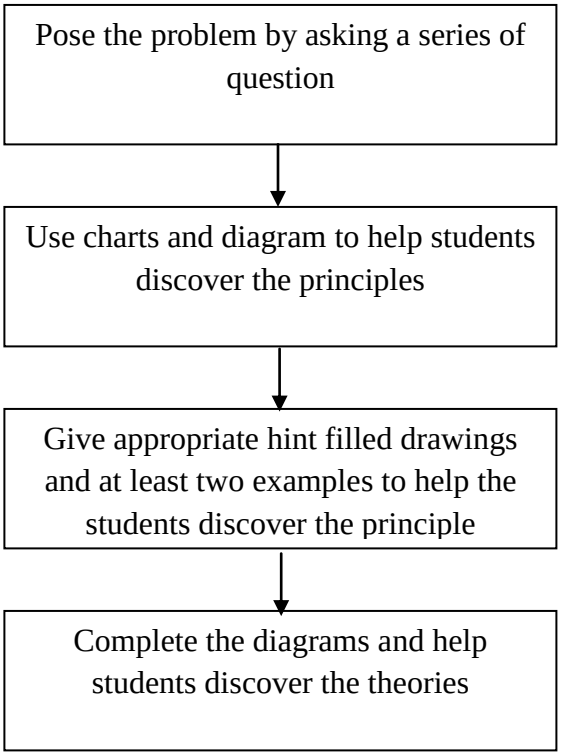


Figure 1.1 Graphic Organizer for Guided Discovery Instructional Strategy
(Source: Bartz 1991)

Organizing your thoughts in this way helps you design the lesson in a logical sequence. Structure the activity so that students build an understanding of each underlying concept individually before putting all of the concepts together into a comprehensive model. As possible, include one or **more** hands-on activities. Analogous models are especially powerful but use them with care - they should really actually show what you want them to show. Design the lesson so that the students must confront common misconceptions as they work.

5. Writing the lesson: At the beginning of the lesson, trigger students' curiosity by making the problem puzzle-like, a mystery to be solved. A real-life scenario can also heighten engagement by showing students the relevance of the material to be learned. For example, in my **Missing Half Dinosaur** problem, the students imagine themselves as being in charge of a dinosaur dig and must correctly interpret a fault in order to locate the missing half of the skeleton.

Make the lesson challenging, but not frustrating or **anxiety**-provoking. Each step should be small enough to feel doable to the student. When incorporating hands-on activities, keep procedures simple and provide clear instructions; the focus should be on understanding what happens, not on doing the experiment "right." Keep the students engaged by keeping busy work, such as repetitive calculations, to a minimum.

The heart of a guided-discovery problem is the leading questions that the students answer along the way. Here is where proper scaffolding is crucial. When well-written, these questions trigger the "Aha!" moments that make guided-discovery problems so exciting and effective. Writing these questions is a delicate balancing act of providing just enough help. If we give too little help, the students feel overwhelmed and give up in frustration. If we give too much help, we rob the students of the thrill of discovery. The students should "gradually see the concepts unfurl" (**Gerver and Sgroi, 2003, p. 9)**. Ask specific questions and make it very clear what you're

asking. Avoid asking too much at once; each question should be just a small step toward the final goal. As appropriate, have students' complete partial diagrams or Tables. Multiple-choice questions can be an effective way to restrict the options available to the students and thus focus their thinking. Frequently ask students to justify their answers, revealing their reasoning. If the remainder of the activity depends upon the correctness of a particular answer, instruct the students request a teacher check before they move on.

6. **Using a naive proofreader:** Before springing a brand-new guided-discovery problem on your students, have a colleague or student work through the activity and uncover any pitfalls such as unclear directions, missing steps, hidden assumptions, or errors.
7. **Writing a follow-up activity to check for accountability:** A guided-discovery problem should be an essential part of the course curriculum, not a fun but irrelevant tangent. Students will not take such lessons seriously unless they know they will be held accountable for the concepts learned. Once, after doing very poorly on an essay question based upon a guided-discovery problem that took the form of a simulation game, a student complained that she had considered it "just a fun game, not something we had to learn." The follow-up activity need not be an exam; it could be another guided-discovery problem that builds on the first, an essay assigned as homework, or a presentation to the class.
8. **Field testing and revising:** Inevitably, your guided-discovery problem will not be perfect the first time, or even the second, third, or fourth. As soon as possible after the lesson, write down what worked, what didn't, and what you would do differently next time. Jot down any ideas for making the lesson more enjoyable or more profound. When I have done so and, especially when I have actually sat down and revised a lesson while it was still fresh in my mind, I have thanked myself profusely the next time I taught that same lesson.

2.3.3 Facilitating Guided-Discovery Problems

Whether you write your own guided-discovery problem or use one written by somebody else, skillful facilitation is crucial to its success as follows:

Preparing the Students: Before the first guided-discovery problem of the course, be especially sure to take some class time to prepare the students for the experience. Students need to know the educational value of everything we ask them to do; they need to buy into guided-discovery problems. If they don't, disaster can result.

Coaching the Students through the Problem: When assigning guided-discovery problems, it is essential to devote some class time for students to work on them. If such time is limited, the early phases of the problem can be assigned as homework. While students are working on the problem in class, skillful scaffolding by the instructor is essential. When students want help, ask them to explain their thinking. Be careful not to evaluate their explanations; instead, note what they reveal about how far the students have gotten in their construction of the concept and exactly where they are stuck. Then give them just enough help (by asking leading questions, providing a piece of **information** or explaining a concept) to get them unstuck. Once they're on the right track and making progress again, joyfully affirm that progress (Students love this!) and then move on.

These kinds of interactions are some of the most rewarding experiences of the researchers' teaching career and the researcher love to spend such time with each and every student. However, even in small classes, it can be very difficult to get to each student individually. Thus the researcher strongly suggests organizing students into groups and insisting on talking to an entire group at a time.

Setting Guidelines for Student Interactions: Guided-discovery problems are ideal for group work. It is best to organize the students into groups of three to five with an even distribution of strong, average and weak students. Instruct them to work together as a team, making sure every member of the team understands the answer to each question before moving on. If strong students resent having to do a lot of explaining, remind them that "the best way to learn something is to teach it" and clue them in on the scaffolding techniques of facilitating student work without giving away the answers.

2.3.4 Concerns and Warnings about Discovery Learning

Recently, Mayer (2004) argued that pure, unassisted discovery-learning practices should be abandoned because of a lack of evidence that such practices improve learning outcomes. Through a review of the literature, he illustrated that unassisted discovery-learning tasks did not help learners discover problem-solving rules, conservation strategies, or programming concepts. Mayer emphasized that although constructivist-based approaches might be beneficial to learning under some circumstances; unassisted discovery learning does not seem advantageous because of its lack of structure. He further emphasized that unassisted discovery-learning tasks involving hands-on activities, even with large group discussions, do not guarantee that learners will understand the task or that they will come into contact with the to-be-learned material.

In a study conducted by Klahr (2009) and others (e.g., Clark, 2009; Mayer, 2009; Rosenshine, 2009 &Sweller, 2009) have emphasized that there are times when more explicit instruction or at least directive guidance is optimal. Although Klahr's concerns were in teaching the control of variables strategy (CVS), his arguments regarding instructional times, feedback, instructional sequences, and generalization of skills, emphasize that in certain situations some amount of direct instruction is advantageous. In the case of CVS, Klahr argues that learners

might have difficulty arriving at the proper strategy of holding all other variables constant while manipulating only one. He explains that such scientific problem solving, while to cognitive scientists who have a great understanding of the cognitive processes involved in such a task, might not arise simply by asking novice learners to figure out how to use the provided materials. Even if such a strategy is reached and implemented by learners, it might require a Running head: great deal of time, which could have been saved through direct teaching of the CVS strategy.

Klahr suggests that perhaps it would be more time efficient to instruct learners directly on how to implement CVS and then give them ample opportunities to practice it. Moreover, direct instruction in CVS learning tasks might be necessary because the manipulation of the materials alone does not provide sufficient feedback; learners are not presented with any indication of shortcomings in their strategies if they fail to manipulate only one variable at a time. By explicitly teaching learners about the cognitive processes involved in problem solving and the ways in which scientists go about uncovering causal factors, Klahr argues that learners will be empowered to use these skills and that their understandings can be strengthened by activities that afford them with opportunities to practice these skills in a domain of interest and consequently, to discover knowledge in that domain by doing so.

Similarly, Sweller, Kirschner, and Clark (2007) have emphasized the usefulness of worked examples over other forms of instruction. They suggest that instructors should provide a complete problem solution for learners to study and practice for themselves. They argue that such a learning technique would be superior to less guided forms of instruction because of the limited capacity of working memory. Thus the problem-solving and guided discovery instructional strategies readily fit in, as they lead students to discover solutions by themselves. Understanding geometric concept leads to easy correct generalization, thus improving students'

skills of problem solving, enhancing discoveries and influencing attitude positively towards the topic.

2.4 The Concept of Problem Solving

Problem-solving strategy is a principal component of Mathematics education from the time of its emergence as a self-sufficient method of finding solution to a problem in science until today. It can be defined as an advanced stage of thinking that involves the individual personal needs to seek a solution to a situation that has never encountered before (Tsoho, 2011). Once a problem arising from a new situation is solved, the individual transfers that learning experience to his everyday thinking. It will never again be a problem of the same magnitude as it was at the first time it occurred. It is therefore, an integral part of the teaching process.

There are many factors that influence problem-solving that teachers must do to facilitate teaching-learning process.

- Teachers must help students recognize when are various strategies appropriate and where and how to use them.
- Teachings must help students become capable of inventing and adapting to strategies.
- Teachers must also help students see the structure of a given problem.

Problem-solving is one of the five process standards of NCTM's principle and standards for school Mathematics, 2000. Problem solving means engaging in a task for which the solution method is not known in advance. In order to find a solution, students must draw on their knowledge and through this process; they will often develop new Mathematical understandings. Solving problems is not only a goal of learning Mathematics but also a goal of learning Mathematics but also a major means to doing so. Student should have frequent opportunities to formulate, grapple with and solve complex problems that require a significant amount of effort

and then be encouraged to reflect on their thinking. Problem-solving therefore, involves taking series of actions in the process of an investigation that seeks to bridge the gap between a problem state and the anticipated goal (Dike, 2008), a strategy that complies action steps taken by the learners to reach anticipated goal when faced with a problem situation.

Problem-solving is the highest form of learning (Bichi, 2002), since the individual defines new ideas based on the process. Likewise, it is well known that when faced with problem, one needs knowledge of rules on the one hand, and the capacity to use them on the other hand, thus achieving transfers of learning. Being able to solve problems enables persons to benefit their environment and to modify it in part (Serrano, Cantu, & Vila, 2003).

Teaching students to solve problems is based on the hypothesis that knowledge is organized and stored in memory in a sequential and logical networks (Permuda, 2004) and hence it can be retrieved in a stepwise and sequential manner to solve problems (Mwelese and Wanjala, 2014). This then means that for successful solution of a problem, knowledge alone may be sufficient. The knowledge of how the conceptual knowledge should be applied (problem-solving skills) in solving problem is equally important. This form of knowledge is called the procedural knowledge on which the theory of problem-solving strategy is based.

Problem-solving as a teaching strategy has been used with a degree of success in Educational sciences (Bichi,2002; Mari, 2005; Bichi, 2006;Mwelese and Wanjala, 2014)). Though, research on problem-solving strategies appears to be copious in social science education literature, there is still paucity of such researches in Mathematics in Nigeria. Furthermore, Oche (2012) has suggested that problem-solving strategies could be employed to effect changes in attitude towards Mathematics. Based on this suggestion therefore, it is possible that problem-

solving teaching strategy in social sciences could be applied successfully in teaching different social science disciplines which may as well facilitate students' achievement in Mathematics.

Oyarole (2012) described problem-solving as the steps taken to search for solution(s) to problem(s). In other words, it is an approach where by students learns to use their knowledge to build on skills and concepts for themselves. It is a method concerned with the creative thinking and "know-how" of everyday life. It is used in developing learner's problem-solving ability which is the major objective of science instruction (Ogwuche & Kurumeh, 2010)). It is so because science has been in the business of finding solution to problems of man kind be it social or scientific. Bichi (2006) identified the role of science education as that of giving a systematic to the individual to enable him/her lead a productive life through day to day solving of his/her problems.

The aim of problem-solving strategy is to build up confidence and ability of learners to solve the kinds of problems that are characteristics of rapidly changing society (Permida, 2004). Therefore, problem-solving processes occupy prominent position in the education training of the learners so as to equip him/her with "weapons" that is necessary for meeting up with future challenges.

Permida (2004) identified some benefits the learner may derive when taught using problem-solving method as:

i. The problem catches the child's attention and that is an effective way of starting a lesson.
ii. Problem-solving exercise can easily be related to the real world.
iii. Problem solving emphasizes process skills rather than facts.

Similarly in support of problem solving method as an effective way of learning Bichi (2002) listed the following reasons:

i. It is an active process.
ii. It takes account of learner's interest.
iii. The process can be related to children's knowledge and experiences.
iv. The process is enjoyable, challenging and motivating.
v. Problem-solving is an important activity of scientists and that learners need to engage in it if they want to understand science.
vi. Skills and attributes acquired through problem-solving are relevant and transferable to the world of work.
vii. Problem-solving can develop social skills by pupils organizing themselves in small co-operative group.

However, for effective use of problem-solving method, it requires the teacher's initiative and capability to formulate challenging problems that will captivate and sustain learners' attention or interest from the beginning of the lesson to the end. (Mari, 2001) considered the following guideline as essential and helpful when deciding problem for learners.

The teacher is to examine the syllabus or scheme of work to find out the theme / concept to be treated. Create a problem situation central to the theme / concept identified in them, and then the problem should satisfy the following criter

- Have potentials for capturing learners' interest and capitalize on it.
- Have few variables as much as possible so as to be within the learners' capabilities.

- Relate to real life situations as much as possible especially those that affect the learners' life e.g. survival problems centered on food, shelter and play tend to attract more attention. Then think of the materials and apparatus the learners' will need in the pursuit of the problem, and get them handy before the lesson, crosscheck before hand to see whether they are functional.

Ploya (1887-1985) was one of the famous Mathematics educations of the 20th century. He believed that skill of problem solving could be and should be taught. It is something that, one is borne with. He therefore, identifies four principles that form the basis for any serious attempt at problem solving.

- Understanding the problem
- Devise a plan
- Carryout the plan
- Look back or reflect.

Odili (2006) in his book Mathematics in Nigeria Secondary School offered a frame work for analyzing how and people are successful or not when they engage on problem-solving. He argued that the following four factors are necessary and sufficient for understanding the quality and success of the problem solving attempts.

- The knowledge base
- Problem solving method
- Control, monitoring and self regulation
- Beliefs and the practices that give rise to them.

More recent studies cited planning and monitoring as key discriminators in problem-solving success and have revealed the influence of various other effective dimensions like beliefs, attitudes and emotions (Balakar, 2006; Adolphus 2011; Kadala, 2014).

Tsoho (2011) noted a consistent finding that problem-solving performance appears to be a function of several independent factors like knowledge, control, beliefs and socio-cultural context. He characterized good Mathematical problem solvers as processing more and well-connected knowledge and rich schemata. They regularly monitor and regulate their problem solving efforts. He further observed that they tend to care about producing elegant solution.

Carlson (2003) drawing from large amount of literature related to problem solving developed a broad taxonomy to characterize major problem solving attitudes that have been identified as relevant to problem solving success. The dimensions of the taxonomy are: Resources, control, methods, Heuristics and Affect.

- Resources: This embraces conceptual understandings, knowledge facts and procedures used during problem solving.
- Control: This includes the selection and implementation of resources and strategies, as well as behaviors that determine the efficiency with which facts, technique and strategies are exploited e.g. planning, monitoring, decision making, conscious Meta cognitive acts etc.
- Methods: The general strategies used when working a problem, like constructing new statements and ideas, carrying out computations, accessing resources.
- Heuristics: More specific procedures and approaches used when working a problem, like observing symmetries using a graph or Table, looking for counter examples, altering the given problem so that it is easier etc.

- Affect: This includes attitudes (enjoyment, motivation interest) beliefs (self-confidence, pride, persistence etc), emotions (joy, frustration, impatience etc) and values/ethics (Mathematical intimacy and integrity).

The ability to solve problem is at the heart of Mathematics. Mathematics is only 'useful' to the extent to which it can be applied to particular situation and it is the ability to apply Mathematics to a variety of situation to which we give the name problem solving. Problem-solving has generally been accepted as a means for advancing thinking skills. For example, in NCTM standards as stated:

"Solving problems is not the only goal of learning Mathematics but also a major means of doing so. In everyday life and in the workplace, being a good problem solver can lead to great advantages … problem solving is an integral part of all Mathematics learning". (NCTM, 2000, 52).

Problem solving performance seems to be enhanced through regular experiences and systematic instruction that aim to assist the development of problem-solving scheme and increase students awareness of problem solving strategies. Active engagement promotes higher problem-solving performance; this can be achieved through relevant or realistic context, and a variety of problem-solving experience including open-ended tasks and investigation. Meta – cognitive strategy and regulation assist problem-solving performance and need to be developed through classroom discussion. In addition, encouraging students to pose their own problems promotes the process of thinking Mathematical. Also, the uses of visual and non-visual reasoning process play an important role in aiding student's problem-solving abilities. Visual methods allow students to negotiate the difficulties associated with a problem when conceptual limitations do not allow a student to complete the problem quickly and analytically.

Subsequently, researchers who believe that there is something to be gained in the classroom through problem solving strategy have conducted series of studies assessing the use of the strategy to enhance teaching and learning process. Ogwuche and Kumreh (2010) conducted a study using this approach and yielded varieties of interesting results.

Other researchers on problem-solving emphasized the role of using the strategy in developing students reasoning skills. According to Mbah (2012) "To lead students to develop accurate criteria for what constitutes a good argument, the teacher must have a solid understanding of problem-solving criteria (P.432) NCTM (2000) also advocates that "Good problems can inspire the exploration of important Mathematics ideas, nurture persistence and reinforce the need to understand and use various strategies, Mathematical properties and relationships" (P. 182).

Teaching Mathematics using problem-solving strategy is like an attractive preposition. The question: How does one implement the process of teaching Mathematics via problem-solving strategy? This question was related to the deeper question of changing the attitudes and beliefs of students who viewed Mathematics as a bunch of definition and algorithms that exist in isolation.

Furthermore, other literatures on problem-solving in Mathematics have extensively discussed the need to teach students to reason mathematically. This led an emergence theme in Mathematics edition in the mid-80 wherein researchers propounded that teaching Mathematics via problem-solving was a correct way to foster students' abilities.

Mwelese and Nwajala (2014) examined the effect of problem solving strategy on secondary school students achievement in circle geometry in Kenya, the study was a true experimental research design based on Solomon Fourfold design. Two Mathematics teachers

with equal qualification, teaching experience and considerable equal teaching potential were selected and trained to teach the two groups. The students were pretested and post-tested after treatment and the findings showed students taught through problem solving had a better achievement. Also the attitude of students was positive when taught through problem solving method than conventional method. This study would form a good base for the present study.

The child is curious by nature. He wants to find out solutions to many problems which sometimes are puzzling even to the adults/ nevertheless, he must be helped to satisfy curiosity, whenever possible by solving various problems

Problem solving is a set of event in which human being work rules to achieve some goal

Problem solving may be defined as process of raising a problem in the minds of students in such way as to stimulate purposeful reflective thinking in arriving at a rational solution.

Problem solving involves concept formation and discovery learning .

Steps in problem solving are

1) Selection and formation of problem
2) Presentation of the problem
3) Formation of hypothesis
4) Collections of relevant data
5) Analysis and organization of data
6) Drawing conclusion
7) Testing of conclusion

In the 1st step, it is the responsibility of the teacher to make clear to the pupils the nature of the problem. The pupil should feel the necessity to find out the solution of the problem. The selection of the problem should be done by both the students and the teacher. Secondly, after selection and formulating the problem. The teacher should also make it clear how this problem can be solved and how the related data can be collected to get the solution. Thirdly, formulation of hypothesis means preparing list of possible reason of the occurrence of the problem formulation of hypothesis develops thinking and reasoning powers of the child. It should be kept in mind that formulated hypothesis must be testable. Fourthly, the child is stimulated to collect data and information in a systematic and scientific manner. The students can refer to even their books. Fifthly, on the basis of collected data, and information , the formulated hypothesis are tested. Finally, conclusions are drawn after the analysis and organizing the data . Here care should be taken that judgments are made only when sufficient data is collected. Discussion and conclusion are to be arranged collectively.

No conclusion should be acceptable without being properly verified . the student must be critical while testing conclusions. Thus the correctness of the conclusion is proved by applying them in new or different situation.

For instance in a geometric class the steps can be summarized as follows

Step I After Selecting and understanding the problem the students will be able to define the problem in their own word

Step II After defining in their own words, the students are to analyze the problem of how it can be solved

Step III After analyzing the various aspect of the problem, the students should be able to make hypothesis

Step IV Then on the basis of the given data, the child will be able to solve the problem

Step V after solving the problem then analyzed of the result on the bases of the given data

Step VI Afterwards, students should be able to generalize the result and apply his knowledge in new situation

MERITS

Merits of problem solving strategy include the following:

- This method is psychological and scientific in nature
- Helps in developing good study habit and reasoning powers
- Helps to improve and apply knowledge and experience
- Stimulates thinking
- Helps develop the power of expression
- Helps students learn how to act in new situation
- Develop good feeling while working together
- Helps to verify an opinion and satisfies curiosity
- Learning becomes more interesting and easily assimilated as it is the result of a purposeful activity
- Maintain discipline class
- Teachers become familiar with his students
- Develop analytical, critical and generalization abilities of the child

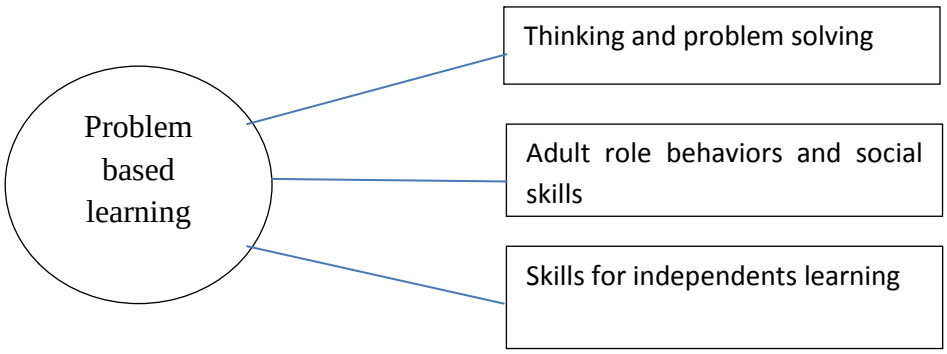


Figure 2.1:Learning Outcome for Problem-Based Learning
Source : (Brown et.al 1989)

Through problem solving, learners are exposed to different strategies of solving problems (Mwelese and Wanjala 2014). This implies that they become curious to see the nature of solutions they get to challenging problems. With time the learners are motivated to solve variations of given problems and then more complex problems. This means learners refine and sharpen their problem skills by solving more problems and this forms the basis for future problem solving endeavor. In the study by Mwelese and Wanjala (2014) the findings of the study indicates that the use of problem solving resulted in significant achievement and learning gains. This positive result was attained because students were allowed to freely solve problems and ask questions since there was an enabling environment of collaborative learning, group discussion and individual participation. As outlined by Wanjala; the results of the problem solving group was good which in turn motivated the learners to like the subject and this made the learners develop positive attitude towards the subject. Different teaching methods draw attention to different learning outcomes (Samuelson 2008). This current study provides support for this view.

2.5 Lecture Method of Teaching and Learning

According to Bello (2014), "Lecture method is an approach to teaching where the teacher's role is to present information that is to be learned to direct the learning process of students. The teacher identifies the lesson objective and takes the primary responsibility for guiding the instruction by explanation and modeling". Harden and Crosby (2000) describe conventional teaching approach as the focus on the teaching transmitting knowledge from the expert to the novice. The teaching strategy is often called traditional or teacher-centered approach of teaching which sometimes resembles a one person show with a captive but largely uninvolved audience. Classes are usually dominated by lectures or direct instruction. The idea is that there is a fixed body of knowledge that the students must come to know. Students are expected to blindly accept the information they are given without questioning the instructor (Hassan, 2014). The teacher seeks to transfer thoughts and meanings to the passive students, leaving little room for students initiated questions, independent thought or instruction between students. The traditional teaching method pays more attention on teachers which in turn helps to decrease students' learning interest to a greater extent. This conventional strategy of teaching is often boring for students because their job in classroom is to passively sit and watch the teacher work Mathematics problems on the board and then copy what the teacher did, few teachers often use learning aids to teach Mathematics.

A commonly used traditional method is the lecture method. It is characterized as a one way flow of information from the instructor, who is always active to the learners who are always passive. The method is the most frequently used method of instruction (Adamu. 2014). The lecture method is indeed an oral presentation intended to present information or teach people about a particular subject. According to Donald (2000), lecture method id the most frequently used method in teaching.

However, presentation of lecture without pausing for interaction with students can be ineffective regardless of the skill of the instructor. In this method, classes are usually dominated by lectures or direct instruction. The idea is that there is a fixed body of know ledge that the students must know. Students are expected to blindly accept the information they are given without questioning the instruction (Hassan, 2014). The teacher seeks to transfer thoughts and meanings to the passive students, leaving little room for students initiated questions, independent thought or instruction between students. The lecture method pays more attention on teachers which in turn helps to decrease students' learning interest to a greater extent. The use of this strategy makes learning boring for students since they are to work Mathematics problems on the chalkboard and then copy. One of the major disadvantages of this strategy is that it gradually makes the students feel Mathematics of no value to real life. At the end of the day, the learners are only forced to study the subject Mathematics and may not be able to apply it in real life.

Research conducted between 1998 and 1999 shows a fluctuating trend in students achievement in Mathematics for the period and also noting the relative increase in the number of candidates that offered the subject from 2001-2005, yet with number of students that obtained credit passes and from the WAEC Chief Examiners report of 1999 and 2003 on students performance in Mathematics, it can be observed that most students were generally not properly trained for the Mathematics examination. Therefore, conscious effort has to be made to prepare these students with a view to enhancing their academic performance in Mathematics.

Advantages of the lecture method

i. It saves time and energy, it's not expensive as only the chalkboard is required.
ii. It offers easy coverage of the syllabus and faster dissemination of scientific information and facts.

iii. It allows easy handling of large classes without much stress.

Disadvantages of the lecture method

i. It does not promote much meaningful learning of Mathematics as it appeals to hearing.
ii. The differences in student's ability are not considered because it cannot satisfy the difference in individuals as slow learners and fast learners.
iii. The students easily become restless and disruptive since their attention span is very limited.
iv. It promotes role learning and regurgitation of information. It does not enhance meaningful learning in Mathematics as observed by various researchers.

Perhaps the most traditional form of instruction, lectures conjure up the image of a stodgy professor droning on and on while his students doodle or even sleep to escape the monotony. However, lecture is often the most efficient way to present or review material with the entire class. Teachers choose to lecture when they have a limited amount of time, when the background information is not available or easily accessible to students (e.g., the material is not in print), or when the concepts could be best clarified through verbal explanation. Of course, lecture works best for older students, as younger students may not be able to absorb information for long periods of time.

There are some drawbacks to using lectures as an instructional tool; namely most "lectures" – as they are most commonly delivered – do not allow frequent interaction between students and the teacher. This disadvantage can be overcome, however, by leaving time at the end for whole-class discussion.

The researcher is not out to completely condemn the lecture method but to seek for ways in which even when it become necessary to use the method it would be adequately used for better performance and attitude in the junior secondary school

Determine the style of your lecture, whether it's a…

- Classical lecture, which works well when you simply want to transmit information;
- Problem-centered lecture, where you offer solutions to a problem with advantages and disadvantages;
- Sequential lecture, where you promote understanding of a subject by giving an extended argument or chain of reasoning that leads to a conclusion; Comparative lecture, where you draw comparisons between new and familiar information; or Thesis lecture, where you make and justify an argument or assertion.
- Focus on reaching clear outcomes. What are your objectives? Write down and tell the students what you what them to walk away with.
- Organize the lecture for your students. Make it easier to take notes by providing students with graphic organizers or outlines at the beginning of your lecture. You can also put a brief outline of the lecture on the blackboard or overhead transparency.

2.5.1 Instructional Methods of Delivery using the Lecture Strategy

- Establish ground rules. Are questions in the middle okay, or should students wait until the end? If you don't want students to interrupt you, you need to teach them to write down their questions so you can address them at the end of the lecture.
- Make modifications for visual learners. Synchronize slides (or overheads) to go with your verbal presentation. Select graphics that represent the ideas, concepts or words.
- Follow the basic strategies for effective oral presentations:

- Use visual cues, such as props, slides, handouts, keywords on the board, diagrams, or pictures.
- Use vocal cues, such as adjusting the volume of your voice and taking advantage of pauses.
- Use signal phrases, like noting that you will be talking about six techniques for writing a great essay opening, which will help them anticipate what you will be saying.
- Tap into the drama, intrigue and relevance of your subject by telling a human-impact story, sharing a personal anecdote, or citing local examples.
- Use body language, such as gesticulating wildly when talking about a tornado, or crouching down when talking about predators and prey.
- Avoid vagueness or indecisive, halting speech, such as "This chemistry lesson might help you understand a little bit more about what is often called a physical change, no, a physical reaction…well, both terms could actually work in this instance. Maybe before we get to what is perhaps the main point of the lesson…"
- Be aware of your non-verbal behavior, such as fidgeting and pacing, which can be distracting.
- Make eye contact and be enthusiastic, sharing why this subject interests you.
- End your lecture clearly. Summarize and highlight the main points. Conclude with the key ideas and how they relate to the future. What should students do with the information from today? Then invite questions and answer questions of students.

This Model of learning has implication for the teacher. It points to the fact that the more the teacher knows about the pre-conceptions, the better for the enhancement of meaningful learning. Meaningful learning does not means the extent to which the teacher tries to furnish the learner

with what they do not know but the learners are engaged in an active continuous process of cognitive structure construction. With this in mind, the learner should be provided with opportunities that will enhance their knowledge construction and build up. It is recongizatble fact that Math is the backbone of science, it must be taught following upon planned

2.6 Related Studies on Guided Discovery Strategy and Problem Solving Strategies Attitude and Performance

In an investigation carried out by Allahoki (2012) on effectiveness of guided discovery teaching method on academic achievement in ecological concepts among secondary school students in Sabon Gari Educational Zone, Kaduna State, Nigeria she sampled 100 students randomly and assigned to experimental and control group using quasi-experimental pretest and posttest design was for the study, at the end of treatment, data collected was analyzed using t-test at $P < 0.05$ significant level, the result obtained show that there is no significant difference between the performance of boys and girls. Also it shows significant difference in student to discovery method of teaching and those exposed to lecture method. She recommends that conference, seminars and workshops should use appropriate experimental techniques in teaching. The difference between the study of Allahoki and the present study is that her study was conducted on ecological concepts while the present research is to be conducted on geometrical concepts. Also the concept of attitude would be considered in the present study. The similarities between this research and the present one are that effects of two strategies are being investigated in the same environment and the discovery method involves discussion and interactions among the students. The present study differs in the area of concepts. The present study is carried out at the Junior Secondary Schools on Geometric concepts and attitude would be considered.

Oyarole (2012) examined the effect of problem solving strategy on students academic achievement and retention in ecological concepts among secondary school student in Zaria

Educational Zone. The sample of the study involves 42 Biology students selected from 2 secondary schools. The study also employs a pretest and post-test quasi experimental design. The finding indicated.

Also, Tsoho (2011) conducted a research on the effect of teaching strategies namely: student centered teaching strategies and problem solving teaching strategy, from his research he opined that the student centered strategy be used in Kano State Junior Secondary Schools. Also Tsoho used the quasi-experimental design which is similar to the design of the present study only that while Tsoho finds the effect of student centered and problem solving and guided discovery in Zaria Local Government Area of Kaduna State.

Again, Ramatu (2012) examined the effect of Demonstration and Discussion method on academic performance of Biology students among senior secondary schools of Zaria Educational Zone. She used the quasi-experimental and control group design involving pre-test and post test. 252 students were randomly selected from two secondary schools forming the sample, she discussed that the overall student performance scores show that t-cal value for the effect of treatment on student performance in diffusion concept was significant at 0.05 level of significant. Thus she states that significant difference students exposed to problem solving performed better than those exposed to lecture method. Hence, it was recommended that the problem solving strategy in teaching science subjects be encouraged. Hence this study would form a good basis for the present research.

At the J.S.S level, emphasis is expected to be on teaching method that can de-emphasis the memorization and regurgitation of facts (Udo 2006). But Ortese (2004) pointed out that the lecture are mostly practiced in the Mathematics class. He therefore opined that the teaching of Mathematics should be child-centered participatory and learning approaches. However,

Ogwuche and Kurumeh (2012) suggested that lecture method should not be totally condemned in Mathematics classes but should be accommodated along with other means to avoid boredom.

The guided discovery method is a teaching technique that assist learners in problem solving the method is child-centered and activity oriented, thereby gives learners the opportunity to discover facts about a particular problem (Dike 2008, Getso, 2008, Olaoye 2007, Oyarole 2012. Guided discovery or inquiry refers to a way of questioning, seeking knowledge or information or finding out about phenomena. It involves investigation, searching, defining a problem, formulating hypothesis (Sola and Ojo 2007). This method gives learner the opportunity to engage in exploitation and sense, making it Mathematics content (Bajah and Askim, 2002). It also gives students self direction to assimilate and accommodate information (Sola and Ojo, 2007).

Many researchers have work extensively on discovery. Nwagbo (2006) revealed that is showed good performance in pupils than expository similarly, Olajide and James (2009) explained it assisted learner to understand problem solving as they learn by experiment. The findings of Ibe (2006) on Guided discovery showed highest mean scores compared to demonstration and the least mean score in conventional.

In terms of gender difference in achievement male shows higher mean score than female. The guided discovery approach has effects on student performance and attitude (Mohammed 2012). In the study of Nwachukwu and Nwosu (2007) it was observed that the success of some known innovative and effective methods may be predicated on the level of exposure students have had in basic day-today method of discovery. Guided discovery method of teaching is a technique that encourages students to take a more active role in their learning process, by

answering a series of questions or solving problems. (Mayer 2003) added that discovery method is based on the notion that learning takes place through classification and formation.

Chianson et al (2011), investigated the effect of constructivist practices through cooperative learning strategies compared with conventional learning method on students retention in circle geometry in senior secondary schools. The findings of the study revealed that students who were subjected to the cooperative learning strategy were able to retain the taught and learnt concepts of circle geometry for a longer period of time more than those students who were taught using the conventional learning approach. That is the result indicated that students in experimental group retained the circle geometry concept longer and could recall faster than those in the control group. This good achievement is attributed to the application of the cooperative learning method. The result supported Anyagh (2006), who discovered that the ability to remember takes place more effectively when experiences are passed across to the learner via an appropriate instructional method. This difference could be attributed to the fact that students in the cooperative learning group were able to follow the guiding rules of working as a group. These rules are simply: explaining to group members what the content is all about; making sure all group member of the group has learnt, comprehended and is able to recall the concept learnt when the need arises. This result is in line with that of Nicolas (2002), who agreed that students in the cooperative treatment group exhibited significant greater gains in the post test and retention test in geometry, learning goal orientation and reported uses of deep processing strategies.

A study conducted by Emmanuel et al. (2009), on the effect of ethno Mathematics teaching approach on senior secondary students' achievement and retention in locus revealed that students exposed to ethno Mathematics teaching approach were superior in achievement and

retention than those taught with conventional approach. Thus, those were significant differences between the mean score of the students' taught locus with ethno Mathematics teaching approach and those taught with the conventional approach in both achievement and retention. Similar results were obtained by Uloko and Usman (2008). The teaching was done in a practical way and as such it follows from home to school and from school to one's trade and to everyday living (Uloko and Ogwuche, 2007). Thus, the abstract nature of teaching and learning of Mathematics seemed to have been reduced. This agreed with the definition of ethno Mathematics by D'Ambrosio (2001), who states that it is approach of teaching and learning of Mathematics that builds on the background, the role his environment play in terms of content and method, and his past and present experience.

Similar results were obtained from earlier observations that a failure in Mathematics in Nigerian Secondary Schools is due to the fact that teaching and learning is purely foreign in nature (Kurumeh, 2004; Uloko, 2006; and Imokom 2007; Uloko and Ogwuche, 2007). The high achievement of students in this study also shows that when Ethno Mathematics teaching approach is used in a practical way it could be an effective teaching approach similar views were held by Bello (2014) and harbor-Peters (2001) who stated that, low achievement of students in Mathematics could be attributed to non-utilization of appropriate teaching approach. Also in this study, the retention mean serves of students taught using Ethno Mathematics teaching approach is higher than the retention means scores of those taught with the conventional approach. Similar results were obtained by Chianson (2008), who found that students in the experimental group retain better knowledge than those in the conventional group.

This current research has a lot in common with the Chainson et al (2011) and Emmanuel et al (2009) studies above especially in the area of instrument, statistics, and design. However,

the bases for the study are distinctively different. While Chainson et al (2011) and Emmanuel et al (2009) were concerned with senior secondary schools in their own studies and with few samples; the present study is to assess the effect of constructivist teaching approach on students' academic achievement, self-concept, retention, and learning of geometry in the junior secondary schools. Also Adamawa State falls outside the areas covered by Chainson et al (2011) and Emmanuel et al (2009). Their findings will however provide a good base for comparison with the result of this study.

Akinyemi et al (2010) investigated constructivism practices through guided discovery approach, the effect on student cognitive achievement in Nigeria senior secondary school physics which is Mathematics related and geometrical in particular. The result showed that guided discovery approaches were the most effective in facilitating student achievement in physics after being taught using a pictorial organizer. This was followed by demonstration while expository was found to be the least effective. Also there exists no significant difference in the achievement of male and female physics student taught with guided discovery, demonstration and expository teaching approaches and corresponding exposure to a practical organizer.

The study of Akinyemi et al (2010) is also similar to the present study especially in terms of design. But while Akinyemi et al were concerned with a constructivist practices through guided discovery approach in the Nigerian senior secondary school physics. This research determined the effect of guided discovery and problem solving strategies on students' performance and attitude in geometry. Hence the findings of Akinyemi et al. formed a base for comparison with the result of this present study.

2.7 The Concept of Geometry

Numerous studies have shown that geometry is of great significance than most areas of Mathematics. (Goldenberg, Cuoco and Mark 2005) claimed that geometry can help students connect with Mathematics. They stated that geometry can connect well with students and them with it. Furthermore, geometry connects richly with the rest of Mathematics including such topics as geometric series, functions, trigonometry and many more. Geometric approaches can be a route into new Mathematical ideas or can provide new insight into Mathematics that students already know.

Another claim by the same research is that geometry can be an idea vehicle for developing different ways of thinking. It is an ideal intellectual territory within which to perform experiments, develop visually based reasoning styles, learn to search for invariants, and use these and other reasoning style to spawn constructive argument as well. Inekwe (2005) expressed concern on the causes as to why geometry receives a general distaste among secondary school students. Following the importance of geometry and the problems associated with the topic, Mathematics educators have developed rigorous empirical methods of instructions and evaluation of what student learn about the concept under various modes of instruction, including the transitional one (i.e. learning without much of the students' participation). Ibrahim (2012) has provided an overview of many aspect of attitude towards Mathematics including review of instruction. Ibrahim (2012) submitted that at every stage, the teacher of Mathematics is confronted with three (3) basic questions namely; i) helping the students to develop understanding and mastery of new concepts, principally, relationships and skills; ii) helping them to maintain understanding and skill already attained and iii) helping them to score maximum transfer of learning to their social environment.

It is however noticed that, some of the literatures discussed here were on Mathematics; this is because it is difficult to separate teaching of geometry from that of Mathematics. It is worthy also to note, that there is no separate geometry syllabus in Nigerian secondary school. However, the researchers from the foregoing, shows that teaching of geometry should be more of student centered/oriented so that teachers could consider the level at which the average students rest and the level of performance among the students they taught.

Geometry can be used almost in all aspect of live (www.ixl.com/Mathematics). The World inhibited by men is world of shapes, and geometry is the only branch of Mathematics that deals with shapes. Geometry represents the wonders of the world. For instance, the pyramids of Egypt, the Hanging Garden of Babylon, the Temple of Artemics, the status of Zeus, mau Soleum of Halicarnassus, Colossus of Rhodes, and the pharos of Alexandria, are all geometrical products that represents the Seven Wonders of the World (Microsoft Encarta, 2008, 2009). The Seven Wonders of the World are the works of art and architecture considered by the ancient Greeks and Romans to be most fabulous creation of antiquity.

Oroke (2013) noted that Egyptians used geometry to build their pyramids given the world its civilization. While others like Pythagoras and Euclid used it to survey and settle disputes. The principle of geometry is applied in various branches of sciences and engineering. Geometry is universal and cuts across every sector of economy including transport system. For instance, motor cycles, cars and airplanes are all geometrical constructions therefore, it will not be over statement to say that geometry is the heart of modern technology that cuts across every sphere of life. However, in spite of these contributions of geometry to society at large, this topic has continued to be disliked and hated by majority of students Oroke (2013) hence the need for this investigation.

2.7.1 Studies on Students' Academic Performance in Mathematical Geometric Concepts

In a study conducted by Kadala (2014) the finding of the study revealed that concept-mapping and project-based instructional strategies could be effective for concept acquisition and development of attitude among the JSS students towards geometry. According to him these instructional strategies are capable of stimulating students for their interaction, discussion of the topics particularly as with concept mapping strategy. Also Askin (2007) discovered that the ability to remembering takes place more effectively when experiences are passed across to the leaner via an appropriate instructional strategy. This difference could be attributed to the fact students in the cooperate learning group were able to follow the guiding rules of working as a group. These rules are: explaining to group members what the content is all about, making sure all group members of the group have learnt, comprehended and are able to recall the concept learnt when the need arises.

A study also conducted by Rasha Wael and Francis (2007) found that a significant effect exists between the performance of male and female physics students taught with guided discovery, demonstration and expository teaching approaches. Again, Akinbobola (2008), Afolabi and Akinbobola (2009) also share similar views when they found that in learning process involving reaching, doing and experiencing such as demonstration, information is better registered because the learner sees the instructors' demonstration. Chanson, Kurumeh and Obida (2010) investigated effect of cooperative strategies compared with lecture method. The findings of the study revealed that students subjected to cooperative learning were not able to retain the taught and learnt concepts of circle geometry for a longer period of time more than those who were taught using Traditional Learning Approach. That means that the experimental group was not able to retain the circle geometric concept longer and could not recall faster than those in the control group. In addition, Akinyemi and Folashade (2010) investigated using guided discovery

approach, the effect on student cognitive performance in Nigeria SSS physics. Their intention was to investigate the effects of teaching approaches (guided discovery, demonstration and expository) on students' cognitive performance in physics after being taught using a pictorial organizer and to determine the effect of gender on students cognitive performance in physics. The result showed guided discovery was the most effective in fascinating student's achievement in physics followed by demonstration. While expository was the least effective, and there was no significant difference in the achievement scores of male and female physics students.

From the literature reviewed so far there is paucity of studies conducted on the effects of guided discovery and problem solving instructional strategies on JSS 2 students mean performance and their attitude scores towards geometry to provide data for decision making from students on their performance with specific reference to the state they belong. The literature also reveals the absence of such a study in Kaduna state Government Junior Secondary Schools.

2.7.2 Factors Affecting Secondary School Students Performance in Geometry

Students feels that geometry is difficult and so develop outright fear, coupled with the difficult nature of the topic, probably most when they come across applicative aspects of Geometry.

There is ample evidence in the literature supporting the view that there exists a relationship between cognitive variables of a spatial nature and learning that is related to geometry concepts. There also appears to be clear indications that developing spatial ability in children is important to this aspect of their learning (Nickson, 2004). Exact relationship between spatial ability and other aspects of Mathematical learning seems less clear (Nickson, 2004), although Musa (2006) asserts that spatial ability is equally important in students construction and use of even non geometric concepts. Balakar (2006) identified two major components of spatial ability that are

relevant to students' learning of geometry as spatial visualization and spatial conceptualization. These are further discussed.

Spatial Visualization

This relates to a student's ability to understand and perform the imagined movements of objects in 2- dimensional and 3- dimensional space (Kadala, 2014) believes that student's ability to interpret figural information and to understand visual representation and vocabulary is relevant to their geometrical learning.

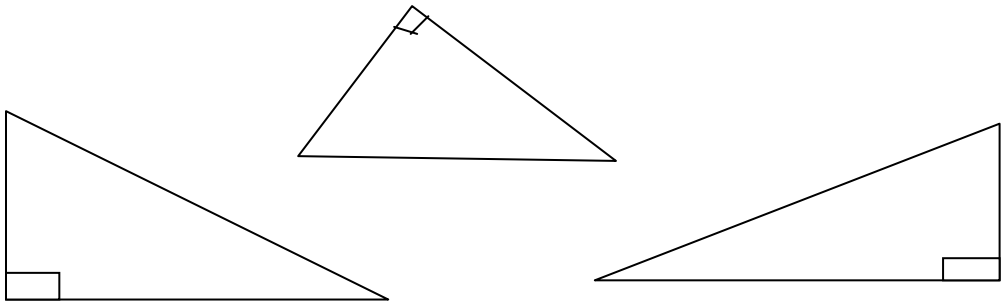
Kadala further describes spatial orientation as the ability of students to recognize a given geometrical shape viewed from different positions. Spatial orientation the understanding of, and operating on the relationships between the positions of spatial objects relative to the viewer's position. Balakar (2006) proposes that developing students' capacity for visual processing, such as the manipulations and transformation of visual representations and images and the translation of abstract relationships into visual representations, are important for acquisition of geometric skills.

Spatial Conceptualization

This is an umbrella term that describes the totality of a student's understanding of spatial objects Kadala (2014). It is evident that geometry has always enjoyed a pride of place in school Mathematics curricula, even in the ancient times of Egyptian and Greek Mathematics. But whether the emphasis on geometry teaching in secondary school Mathematics has yielded results commensurate with the associated human and material investment as by students' success rate in the subject, is an issue over which educators and stakeholders have expressed concern in Nigeria in recent years.

Noticeably in the volume of abstraction involved in Mathematics teaching and learning process at the JSS level. The most obvious example is in geometry. In many respects JSS geometry resembles the abstract Mathematics of higher institutions like College of Education, Polytechnic and Universities Mathematics. The study of geometry poses a number of difficulties to learners, somewhat different in nature from those present in Arithmetic and Algebraic expressions, due to its primarily visual nature (Balakar, 2006). Whereas in Arithmetic, written numerals represent numbers, the actual shape of the numeral bears no relationship to the number. In geometry a concept of say, triangle and its written form are essentially one and the same the following three examples illustrate these points:

i. Since rectangles are always drawn with unequal adjacent sides, many students think this inequality is part of the definition of a triangle and fail to realize that squares are also rectangles.
ii. The length of the arms of an angle are not part of definition of the size of an angle, but since longer arms increase the overall size of the angle configuration, it can easily be thought that longer arms mean larger angles as seen in Figures.



iii. Ideas and definition concerning triangles tend to be introduced using triangles in different positions. Many students have difficulty in identifying the Hypotenuse, the adjacent and opposite sides of angles as shown in ii. Since geometry is primarily a visual subject, there is no way of avoiding this conflict between the partial and the general. The process of

learning geometry requires the ability to distinguish the essential features, which particular configuration is drawn to illustrate, from additional and irrelevant feature Kadala (2014).

2.7.3 Causes of Learning Difficulty in School Geometry

Most of available literature continued to reveal there is low performance in Mathematics among Nigerian students, Harber-Peters and Ije (2005) Ohakwe (2006), Atebe (2008). Consequently, Atebe (2008) opined that performances in Mathematics are low and as a whole could be taken as good indicator of performance in geometry. By way of extension, it also means that Nigerian students' knowledge of geometry could be said to have fallen below expectations supported by the WAEC chief examiner's report (2000; 2002; 2005) which states that candidates were observed to be generally weak in the area of geometry, as a result many students dislike geometry. Unal (2005), Atebe (2008) and Adolphus, (2011) also reported similar observations among Nigerian students. Most of the literature reported the area of difficulty to include, misconception about geometrical shapes and relationship between their proportion, imprecise terminology, identification and classification of shapes, proof writing in geometry. Geometry stresses the use of language more than any course both inside and outside the classroom. In addition, most literature indicate the source of learning difficulties in School geometry cut across the globe and have been attributed to several factors. These factors have been categorized into student factor, teacher's factor, curriculum text and instructional/pedagogical factor etc. Ali (2000); Aburime (2003; Agwagah (2005); Umal (2005); Odidi (2006); Ohakwe (2006); Mahwah (2007); Olaoye (2007); Adedibu and Olayiwola (2007); and Atebe (2008).

Since these factors mentioned above are not the only critical influence on students learning of geometric, they do have a major impacts and their evaluation does give insight into

the roles they play among the expected, implemented and attained individual objectives, (Fujita and Jones, 2002).

Some literature reviews that much of the difficulty that students faced with geometry is due to teacher's lack of appropriate pedagogical contents in this subject, Van Hiele (1986), Jones (2000), Ohakwe (2006), and Mahwah (2007). These literatures cited confirmed that children's knowledge and teachers understanding of that knowledge are the major determinants to instructional decision making.

In Nigeria several factors were identified as the cause of student's poor performance and attitude in Mathematics with emphasis on instructional strategies as the most critical factor. Others are teacher's qualification, student's family background, school environment and curriculum. It is in this light that most literatures seem to agree that all is not well with the teaching and learning of Mathematics and geometry in particular. Adolphus (2011); Ahmed (2014). However it is assumed that, an improvement in students learning assumes an improvement in the pedagogy enabling learning. Relating to the causes of difficulty in school geometry are the all important issue of teacher's 'reluctance to change' for new and progressive methods of teaching. Probably the reason for this is that, it seems it will require teachers to adapt radically to different teaching styles (Mary and Lourdes, 2005). Hence, this is true with many teachers who use the lecture method. This is contrary to the world acclaimed learner centered, the social constructivist approach, (Pollard et al, 2006). Teachers students Mathematical thinking and the learner centered is the most appropriate in geometry instruction, Ahmed (2014). Therefore the effect of guided discovery and problem solving strategies on students' performance and attitude towards geometric concepts among JSS students in Kaduna state.

2.8 Secondary School Students' Attitude towards Geometric Concepts

Many science educators have attributed a great importance to the effective domain characterized by variety of constructs such as attitude, preferences and interest (Schibeci 1994 and Sjoberg, 2002). Attitude has been defined by Yara (2009) as an individual way of thinking, acting and behaving. Also Osborne (2009) defined attitude as feelings, beliefs and values an individual held about an object that may be the enterprise of science on society or scientists. This will have a serious implication for teaching and learning process in science – this has the potential to either facilitate or inhibit learning (Yara, 2009).

Attitudes are formed as a result of some kind of learning experience which consequently will affect the outcomes in science teaching and learning (Yara, 2009 and Mohammed, 2012) Research studies have identified some factors influencing attitudes toward science and Mathematics; this includes gender, personality, environmental and curriculum variables. Bolaji (2005) in a study of the influence of student's attitude towards Mathematics scores found that the teachers' method of Mathematics teaching and personality greatly accounted for students' positive attitude towards Mathematics. In comparison Pickens (2005) clarified that attitude might help us to define how students can see the different situations, how they behave in situations and reflect their feelings, thought, and actions. Hence attitude gives a view about the structure of the internal beliefs, thoughts, and how these two components affect students' behavior in different situations. Overall and Sangster (2006) state that there is need for research into the roles that beliefs might play in opening up possibilities of deeper Mathematical understandings involving students achievement and attitude. Thus, the present study accepts the two dimensional views of attitude namely: the dimension of emotion that includes more sub-variable, such as enjoyment, confidence, motivation, frustration and fear of geometry and the dimension of beliefs that include students' thoughts and perceptions about the importance of geometry concepts in

classroom context, in real world situations, the importance and functions of geometry. Both dimensions form students' behavior which indicates the readiness to participate in geometry class discussions, showing understanding of geometric concepts and sharing ideas and collaborate with class partners.

A critical look at the reviewed studies shows that there are conflicting reports concerning the relationship between student's performance and attitude in learning Mathematics and geometry in particular. It is against this background that the present study would seek to establish the relationship, if any, between student's performance scores and attitude towards geometry at JSS level in Zaria Local Government Area.

2.9 Studies on Gender and Performance in Geometric Concepts

The need for a sound Mathematical knowledge has continued to receive attention in today's modern world of science and technology (Hassan 2010). This implies that for any country to develop scientifically and technologically, it definitely needs a sound knowledge of Mathematics, beginning at the foundation level of education. In fact, Mohammed (1990) calls Mathematics the "queen of sciences".

A search for a better performance in Mathematics at all levels has continued to be the untiring efforts of Mathematics educators' world over. These efforts include better teaching methods and strategies to better performance and also the issue of gender-related differences that has caused a lot of debate. For instance, Summer (2005) has empathically declared that "Mathematics is a man's game… Overall and Sangster (2006), Yara(2009), Ahmed (2014) has however, found out that at the lower level of education, differences in Mathematics abilities of boys and girls are not much noticed. Fennema (1980) came to notice that higher cognitive tasks in Mathematics tend to favor males.

However, on a contrary, Kajuru and Kaura (2010) had found out in a study conducted in two primary schools in Kaduna state that boys has an upper hand over their girls counterparts when they experimented using constructionist teaching strategy to teach addition and subtraction. In one critical review of researches Spelke (2005) had considered 3 claims that cognitive sex differences account for the differential representation of men and women in high level career in Mathematics and science:

a. That males are more focused on objects from the beginning of life and are therefore predisposed to better learning about mechanical systems,
b. That males have profile of spatial and numerical abilities producing greater attitude for Mathematics; and
c. Males have variable cognitive abilities and therefore predominate at the upper reaches of Mathematical talent.

Spelke (2005) found that research on cognitive development in human infants, preschool children and students at all levels fails to support these claims instead, she said, it provides evidence that Mathematics and scientific reasoning develop from a set of biological based cognitive capacities that males and females share. These capacities, she said lead men and women to develop equal talent for Mathematics and science.

Mary and Lourdes (2005) stated that reviewers have consistently concluded that males perform better in Mathematics tests than females do. To make a refined assessment of the magnitude of gender difference in Mathematics performance they performed Meta analysis of 100 studies. The result of the study showed that for average over-all effect sizes based on samples of the general population, mean difference was – 0.05, indicating that females out performed males by only a negligible amount. For computation, mean difference was – 0.14 (the

negative value indicating superior performance by females. For understanding of Mathematical concepts, mean difference was 0.03.

For complex problem solving, mean difference was 0.08. An examination by age of age indicated that girls showed a slight superiority in computation in elementary school and middle school. There were no gender differences in problem solving in elementary or middle school, differences favoring men emerged in high school (mean difference = 0.32) Gender differences were reported to be smallest and actually favored females in samples of the general population grew larger with increasingly selective samples and were largest for highly precocious persons. Hyde, et al (1990) also reported that the magnitude of gender difference has declined over the years for studies published in 1973 or earlier (mean difference was 0.31), whereas it was 0.14 in 1974 or later. Hyde et al (1990) concluded that gender difference in Mathematics performance is small. Nonetheless, the lower performance of women in problem solving that was evident in high school required attention.

In another study to examine whether the tendency for girls to out-perform boys in the classroom is due to difference in how girls and boys approach school work was conducted by Kenney – Benson, Pomerantz, Ryan and Patrick (2006). In 5^{th} grade and then 7^{th} grade, children (N = 518). The report was that girls were more likely than boys to hold mastery of performance goals and to refrain from disruptive classroom behavior which predicted girls' greater effortful learning over time. The sex difference in learning strategies accounted for girls' edge over boys in terms of grades. Girls did not do better on achievement tests, possibly, they said, because self efficacy, for which there was no sex difference, was the central predictor on performance on achievement tests.

Haralambo and Holborn (2008) reported that in the U.K, girls and young women are out performing their male counterpart at every level of educational system – from primary school to university. This, they say, is dramatic and worldwide change that has happened during the last twenty-five years. They went on to say that unlike in the 1970s when the focus of research was on girls "under achievement" in the 1990s it has been "under achievement" boys who have been the focus of gender research in education.

In the U.K boys have complained that their 'under achievement' comes as a result of the way schools are run, the organization of teaching and learning, and the examination system all discriminate against them. That feminism has gone too far in empowering girls and feminizing the curriculum and assessment procedures. That teachers fail to meet boy's learning needs and fail to appreciate and understand their masculinity. That female teacher dominates the schools where they control and suppress 'boyness'. This discourse suggests that schools should be made more 'masculine' and that attention and resources should be redirected from girls to boys, Francis (2006).

Spurlock (2001) has found out that from the 1990s girls priorities had changed: love, marriage, husband…" to jobs/careers. He said this change may help to explain why the educational attainment of girls at school is now greater than that of the boys. Gill born and Mirza (2000) have asserted that 'class' has five times the effect on educational attainment than gender has and ethnicity has twice the effect. But they say we cannot leave the effect of gender on educational attainment because it is still very significant. Some of these reviews show that there have been dramatic reversal trend in gender related difference in performance in Mathematics at the lower levels in the foreign countries. It may therefore not be out of place to conduct a study of this type to ascertain how gender-related performance in Mathematics is obtained in one's

environment. In Nigeria, we hope that one day what is attained in the western countries would be attained.

In Nigeria, gender achievement studies include Akanmu and Fajemidagba (2006) who found no significant relationship between gender and achievement in algebraic processes and statistics but found a weak significant relationship in geometry and trigonometry. Also Takawira and Mathias (2010) reported significance gender difference in mean achievement score in Mathematics among JSS students. To contribute to the realization of the Millennium Development Goals on the promotion of gender equality, Sam et al (2010) reported existence of significant gender achievement gap in favor of the rural males. Further, researches have revealed determinants such as socio-economic status, students interest and attitude as having effects on performance of learners. Abubakar and Dokubo (2011) investigated the effect of gender as predictors of academic performance of Mathematics students. The primary concern which this result brings to mind is the cause of the poor achievement of Nigerian secondary school students most especially in Zaria among some questions that need to be answered is whether teachers have applied good instructional strategies, therefore, the need to find out if guided discovery and problem solving strategies are capable of eradicating this gender related difference in performance and attitude towards geometry among JSS students in Zaria Local Government.

2.10 Overview of Related Studies

Several studies have been carried out on Problem-Solving and Guided Discovery instructional strategies in Basic Sciences such as: Physics, Chemistry and Biology among other but little have been done in Geometry. The review of this studies help in no small measure they throw more light on the use of Problem-solving and Guided-Discovery instructional strategies in teaching and simplifying learning of geometric concepts

The overview would be presented in the following order:

- Name of author and dates
- Place of studies and level of study
- Research design used
- Sample size
- Instrumentation
- Statistical tools used
- Conclusion and
- Findings

In a study conducted by Tenebaum (2011) on discovery based instruction, two meta-analyses were conducted using a sample of 164. He first examined the effects of unassisted discovery learning versus other types of instruction, Random effects analysis of 580 comparisons revealed that outcomes were favorable for explicit instruction when compared to unassisted discovery under most conditions. In contrast, analysis of 360 comparisons revealed that outcomes were favorable for enhanced discovery when compared to other forms of instruction. The finding of the study suggests that unassisted discovery does not benefit learners whereas feedback, worked examples scaffolding and elicited explanation do. This research was also a useful guide for the present research

Gunham (2014) published a Journal in South Africa and the aim of the study was to evaluate the reasoning skills in geometry-related subject of six 8^{th} grade students. The study data were obtained at the end of the 2011-2012 spring periods in a public elementary school. The study used six geometry problems to collect the study data. The students were asked to think aloud when solving the problems so as to be better able to explain their thoughts. From the data

obtained, it was identified that the process involved when demonstrating reasoning skills showed a number of differences. The participants in this study were selected according to their level of achievement (High, Medium, low) in the math class and their willingness to voluntarily participate in the study and so the exception sampling techniques was used. The questions used for data collection in the study were multiple choice examination questions for 8^{th} grade student. A clinical interview was performed, while the six students were solving the geometry questions. Gunhan concluded that when it comes to geometrical concept students ought to be presented problems that allow them to use different reasoning skills. This research work was also a good basis for the present researcher.

Ezenewa (1993) conducted a research titled "Comparative study of the effectiveness of concept mapping and guided discovery teaching strategies on secondary school students' understanding of selected chemistry concept. The study sample consisted of 246 (SS1) Chemistry students drawn from 3 randomly selected secondary school in Niger State of Nigeria of which both group were pretested and post tested. The major instruments used were chemistry attitude questionnaire, Home factor questionnaire Chemistry Concept achievement Test, reasoning ability test and reading comprehension test. The findings of the study indicated that concept mapping group performed significantly better and retained more of the selected chemistry concept than the guided discovery group. Also there was no significant difference in the performance of boys and girls taught using concept mapping and discovery strategies, there was no significant relation between any of the home factors and performance in Chemistry. This study was also helpful for the present researcher

Fajemidagba (2013) investigated the effect of guided discovery learning strategy on students' performance in Math alongside influence of gender and scoring levels ability of the students. 202

SS1 students from two selected public co-educational schools in Ejibo LGA of Osun state constituted the Sample of the study the research was a quasi-experimental one and the main instrument for data collection was 20-item multiple choice math Achievement test drawn from West African Examination Council past questions on Set Theory. Results revealed a significant difference in favor of those exposed to Guided-Discovery strategy. Also both male and female students performed equally well when taught using Guided-Discovery strategy, the study shows that high scoring students benefited most while the performance of low scoring students was also enhanced. The review of this study was also useful to the present study.

In a study conducted by Mwelese & Wanjala (2014) on effect of problem solving strategy in Kenya on secondary school students' Achievement in circle Geometry. A True experimental design based on Solomon four-fold design was used. The sample population was 160 with each school producing 40 students/ the study employed multi-stage sampling techniques. In the experimental groups, one group was pretested treated then post tested while the other one was only treated then post tested. Also in the control groups, one group was pretested and then later post tested while the other group was only post tested. Questionnaires, mathematics Achievement test and an interview schedule were used to collect information from the subjects. The score were used to compare the group taught using problem solving strategy and those taught conventionally. The data obtained from the study were analyzed in terms qualitative and qualitative descriptions. Description statistics consisted of percentages, mean and standard deviations. Inferential statistics used here included analysis of variance, t-test included analysis which were employed to determine the significance of the difference in students in students' achievement, interests and attitude during math lessons. Interpretations shows there was no significant difference in general performance on GPT between the two group on pretest. However the treatment, there was a significant difference on the achievement test between the

control and experimental groups. The results therefore suggested that the students who were taught math using problem solving performed significantly better than those taught conventionally. Also the students developed positive attitude when taught using problem solving method. This study was a useful guide for the present study

Dike (2008) investigated the effects of problem-solving strategy and lecture on socio cultural beliefs hindering science learning in some selected junior secondary school in Gwagwalada. In her study pretest post-test quasi-experimental design was uded for data collection which included social cultural belief scale (SCBS) and integrated science Achievement Test (ISAT). The sample was made up of one hundred Junior Secondary School One (JSS 1) students randomly selected from two co-educational public secondary schools. The data were analyzed using Wilcoxon statistics t-test and spearman rank statistics at $P \leq 0.05$ level of significance. The major findings obtained from the study were; there was no significant difference in pretest and post test mean scores of the students in socio-cultural belief scales when taught using problem solving. There was significant difference in the mean scores of students in socio-cultural belief of those taught using problem solving strategy and those taught using lecture. There was significant difference in the mean score of male and female in their academic achievement when taught using problem-solving. This research work was also useful to the present researcher.

Kadala (2014) investigated the effect of concept-mapping and project based instructional strategies in Adamawa State. The study a quasi-experiment with pre-test, post-test control group design adopted 3X2 factorial analyses was employed for variable matching. The sample consisted of 380 Government Junior Secondary School students. The research instruments used were SGAQ and GPT. The finding indicated that the concept mapping had significant effect on

the students geometric performance and there was a positive attitude indication. The study recommended that students should be encouraged to put more interest in geometry by informing them on the importance of geometry to modern science and technology in general by the use of concept-mapping and project-based strategies. This review of this study was also good basis for the present research.

Oyarole (2012) examined the effects of problem solving strategy on student's academic performance and retention in ecological concept of SSS biology in Zaria Educational Zone of Kaduna State, Nigeria. The study employed pre-test quasi-experiment design, the population of the study covered all 684 SS1 science students in the public school under Zaria Zone. A sample of forty-two SS 2 Biology Students selected from two Government Schools. Samples of Schools were drawn using stratified sampling and simple random sampling techniques in selection of students. The study employed a pre-test and post-test quasi experiment design. Two instrument were developed by the researcher and validated by science expert namely : Ecological Achievement Test (EAT) and Ecology retention test (ERT). The data collected were analyzed using descriptive statistics and t test for hypothesis finding indicated that students exposed to problem solving performed better than those of lecture method. This study served as a useful guide to the present research.

A major question not yet properly addressed by most of the literatures reviewed is what could be done to improve attitude and increase interest of students for a better performance in Mathematics? Some of the instructional strategies suggested by most researchers for teaching of Mathematics may not yield the desired results of changing the negative attitude of Mathematics in the eyes of the leaner and attendant low/poor performance syndrome. This could be attributed

to the fact that some of the strategies have not incorporated what the learner already know and how the learner reasons and ability to solve problems.

Okwute (2013) investigated the effect of guided Discovery method on mathematics performance of low and high averted Secondary school students in FCT, Abuja Nigeria. The study pointed out the meaning, difficulties among students. The data for the study was collected by administering two form of test (MAT and MARS) to 207 students selected rom GSSS Kwali, Yangoli, Ditse Sagwari, and Bwari. The statistics means, standard deviation and t-test were used to analysed the data. The finding indicated that student with low Math aversion performed better when exposed to guided Discovery strategy. This study was also a useful guide for the present researcher.

In the literature reviewed, researchers have shown that various teaching methods are used in teaching geometry at the Secondary School level. Thus, the selection of suiTable instructional strategies will assist learner to effectively grab and develop positive attitudes toward the subject matter.

Mathematics teaching especially at the Junior Secondary School level is to be student centered oriented. Therefore, the Mathematics teacher ought to possess the ability to apply special knowledge and skills in selecting and making use of different kinds of instructional strategies suitable for any particular purpose. It has been revealed that Mathematics teaching is affected by inadequate instructional strategies.

Like any other subject taught in the Junior Secondary School, Mathematics has its own curriculum which is unique. In the Mathematics curriculum, performance objectives, content activities, materials and evaluation strategies accompany every topic. This pattern can help

develop the learners basic knowledge and skills in Mathematics and develop their attitude in Mathematics and geometric concepts in particular.

Many researchers have reported that the manner and ways in which geometry at the primary and junior secondary school has a significant effect on their achievement and attitude towards science. It has been revealed that attitude towards geometric concepts are influenced by a number of variables. Among the important variables related to attitudes towards geometry at the JSS level are geometric achievement and gender.

Attitude seems to account for some significant percentage of the difference in academic achievement in geometry. Therefore, higher achievement in geometry is linked to positive attitude towards geometric concept learning.

Researchers in Mathematics education have shown their concern on gender related issues. This includes under-representation and achievement among the sexes. Some studies have reported gender disparity in science achievement while other works showed on significant difference in Mathematics achievement according to gender.

Both achievement and attitude play vital roles in teaching and learning of Mathematics and geometric concept at the junior secondary school level. In this regards, strategies need to be developed in order to enhance achievement and sustain learners' attitude toward Mathematics and geometrical concept. Therefore, it becomes imperative to investigate the effect of guided-discovery and problem-solving strategies on JSS academic achievement and attitude toward geometric concept. This will help in determining the extent to which it can contribute to the teaching and learning of geometry.

Guided-discovery and problem-solving teaching strategies engages students in gaining knowledge and skills through an extended inquiry process structured around complex, authentic questions and designed products and tasks. Studies have shown the effectiveness of these teaching strategies on students' performance in science. There has been little done in geometry with regard to the use of guided-discovery and problem-solving.

A major question not yet properly addressed by most of the literatures reviewed is what could be done to improve attitude and increase interest of students for a better performance in Mathematics? Some of the instructional strategies suggested by most researchers for teaching of Mathematics may not yield the desired results of changing the negative attitude of Mathematics in the eyes of the leaner and attendant low/poor performance syndrome. This could be attributed to the fact that some of the strategies have not incorporated what the learner already know and how the learner reasons and ability to solve problems.

Evidence abounds which shows that the lecture method of teaching is inadequate for improving students' performance and attitude towards geometry (Aiyede, 2007; Eniayeju,(2010). This underscores the need to shift from the lecture method of teaching and embrace some other instructional strategies that have been found to have facilitative effect in prompting students' active participation like problem-solving and guided-discovery strategies. Both strategies influence students' performance and attitude and exhibited superiority over other methods of teaching because of the student's active involvement. Thus the need for the study. The literatures are quite useful guide for this study. However, few clear patterns emerged from it. These might be due to variability techniques and students grade levels. However, many studies reviewed indicated that students' level of acquisition of geometrical concepts and attitude are rather low.

2.11 Implication of Reviewed Literature on the Present Study

In the paragraphs above, a lot of literatures have been reviewed leading to the insight about the topic being investigated. The finding of this literature has some implication for the present study. For quite a long time, Mathematics teachers have been restless searching for effective instructional strategies and fruitful curriculum materials that would collectively foster the teaching of science to the younger generation. The finding of most of those studies concluded that academic performance is enhanced by using effective instructional strategies which recognize active student's participation. Many of these studies have been reviewed on the effect of effective teaching strategies on gender differences in academic achievement.

From all indications, all is not well with the teaching and learning of Mathematics and most specifically geometric concepts in the Nigerian public Secondary Schools. According to Mstem (2011) one of the problems making teaching of Mathematics difficult are pedagogical in nature. Mohammed (2004) and Mbah (2012) amounted to positive relationship between teacher's qualifications and student achievement and hence concluded that trained and experienced teachers in the method of teaching and skills of instructional strategies teach with better relevance to students' needs and aspiration towards effective understandings.

Also to Mary and Lourdes (2005) the most effective type of instruction includes brief presentation followed by recitation and application. Agwagah (2005) stated that the lecture method has failed to produce good results over the years especially in developing countries such as Nigeria. Akinbobola (2008) stress the fact that most students are not able to apply knowledge acquired in the classroom environment to other situations outside because they lack the basic understanding of the subject.

Also Nwelese and Nwajala (2014) observed lack of appropriate cognitive skills by students in the subject. While Adebayo, (2001) and Amoo, (2002) observed the lack of using instructional material due to lack of materials contribute to poor performance in the teaching and learning of Mathematics. Betiku, (2001) maintains that poor foundation at Primary School as a result of incompetent teachers and psychological fear of the subject Efunbanjo, (2001) identified teachers haste to covering many topics within a short time as another serious problems.

A lot of factors have been indicated as contributing to students' poor performance and negative attitude towards the learning of geometry. Some of which include the strategies employed by most teachers, teaching and learning facilities and sex-role stereotyping. Research have shown that predominant use of the lecture method probably because of the population of students in our public secondary schools, inadequate instructional facilities and marginalization if female students have adversely hindered high achievement and brought about negative attitude towards Mathematics and most specifically geometric concepts.

In addition, the study seeks to ascertain the extent to which gender differences in Mathematics performance can be noticed in our JSS and at the lower level of education. The reviews from the western foreign countries shows dramatic reversal trend in gender-related differences in performance which had not yet been attained in Nigeria though considerable improvement is being noticed. To this effect, Kachii (2005) found that under-achievement in Mathematics is due to the fact that girls are assigned too much work at home. This girl child 'overwork' may be one reason that has prevented Nigeria girls from achieving greatly in Mathematics.

More so, Dike (2008) suggested that educators should provide culturally appropriate activities and teaching and learning methods that reflects culturally diverse students' learning styles.

Furthermore a multicultural teaching of Mathematics provides more meaning and makes students motivated and co-operation in learning Mathematics.

Problem-solving and Guided-Discovery teaching strategies engages students in gaining knowledge and skills though an extending inquiry process structured around complex, authentic question and designed products and task. Studies have shown the effectiveness of these teaching strategies on students' performance in sciences. In Nigeria, the science in which studies have been carried out include: Physics, Biology, Chemistry, and Mathematics Among others.

It is however, interesting to note that most of the studies have been carried out in subject area other than a few in geometry. There has been a few research of this kind carried in geometry with regard to the use of Guided-Discovery and Problem-solving instructional strategies. Also a few of such research has been carried out using Kaduna State

CHAPTER THREE

REASEARCH METHODOLOGY

3.1 Introduction

The Purpose of this study was to investigate the effects of Problem Solving and Guided Discovery Instructional strategies on JSS performance and Attitude towards geometric concept in Kaduna State. In this chapter the methodology is presented in the following sub-heading

3.2 Research Design

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Instrumentation

3.6 Validity

3.7 Pilot Study

3.8 Reliability of the Instrument

3.9 Administration of Treatment

3.10 Procedure for Data Collection

3.11 Procedure for Data Analysis

3.2 Research Design

This study used a quasi-experimental research with pretest post test control group design. This was because the independent variables cannot be fully controlled. The design made use of 3X2 factorial analysis for matching variables. The factorial design was used because of the experimental nature of the study such as lacking the complete randomization and to ensure proper matching of the variable involved. The treatment was manipulated at three levels namely,. Problem solving, Guided discovery and lecture method and the interaction effect of gender at

two levels (male and female). The treatment and gender are crossed in 3X2 factorial designs. The factorials design has been chosen because it allow for separate determination of the effect of treatment on the learning outcome (Kerlinger, 1986). The conceptual model of the design is illustrated.

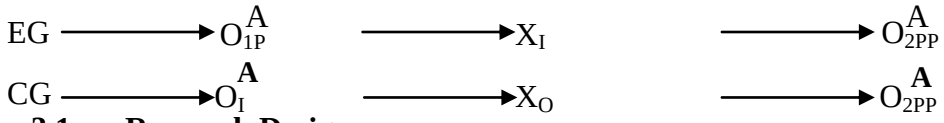


Figure 3.1: Research Design

A = Attitude

P = Performance

EG = Experiment Group

CG = Control Group

X_1 = Use of guided-discovery and problem-solving strategies

X_O = Lecture method

O^{A}_{1P} = Pre-test (to ascertain group equivalence of the learners)

O^{A}_{2P} = Post-test (to find out effect of treatment)

3.3 Population of the Study

The study area consisted of 12 educational zones in Kaduna state which together sums up to a total of five hundred and twenty three (523) Secondary Schools. The schools were made up of both single and mixed schools. The average age of the JSS 2 students is fifteen years. The population is made up of two thousand nine hundred and fifty four females (2954) and three thousand four hundred and seventy seven males. The single sex schools are five male Junior Secondary Schools and five female only Junior Secondary Schools.

The detail of the population is presented in Table 3.1.

Table 3.1: Population

Zone	Male	Females	Total
Anchau	1962	648	2610
Birnin Gwari	431	957	1388
Giwa	1091	611	1702
Godo Godo	1637	957	2594
Kachia	1478	1016	2494
Kafanchan	1689	1305	2994
Kaduna	2049	2017	4066
Lere	1564	544	2108
Riga Chikun	1040	656	1696
Sabon Tasha	1878	1420	3298
Zaria	3144	1463	4607
Zonkwa	1251	1025	2276
Total	19214	12619	31833

Source: (KADUNA STATE MINISTRY OF EDUCATION OFFICE ,2014).

3.4 Sample and Sampling Technique

The subject of the study were all Government Junior Secondary School (GJSS II) students from Kaduna State. All were co-educational. The schools were selected at random using stratified random sampling techniques. The sampling was based on the stratified random sampling three schools out of the thirty Junior Secondary schools in Kaduna state. In selecting the schools for this study, certain criteria were considered, these were qualification of Math teacher and basic infrastructural facilities in the schools. Eight schools that met these criteria were randomly selected. However, three schools were randomly assigned by balloting to each experimental

group and the other schools were for control group. Thus this research considered 381 GJSS II students, comprising of 195 boys and 186 girls

Table 3.2: Sample for the Study

Zone	Population	Sample
Anchau	2610	120
Kaduna	4,066	112
Zaria	4607	149
Total	11283	381

The sampled schools were grouped into two experimental groups and one control group using random sampling technique (use of balloting) by picking paper from the hat, involving rolling three (3) papers with code 01, 02, 03, representing the schools. In which code 01 and 02 are for the experimental groups (I and II) while 03 is for the control group.

3.5 Instrumentation

The instruments used for this study were:

i. Geometric Performance Test (GPT)
ii. Students Attitude Questionnaire called Geometric Concepts Attitude Questionnaire (GCAQ)

3.5.1 Geometric Performance Test (GPT)

The Geometric Performance Test was constructed by the researcher. It consisted of 40 multiple choice objective questions with five options drawn from the topics taught to the subjects. The topics were properties of plane shapes, connections between quadrilaterals, Angles between lines, Angles in triangles, Angles in quadrilaterals, and polygons. Students were

required to choose the options that bear the correct answers to the questions and the test was designed to last for a period of 40 minutes.

Table 3.3 contained questions set across the content domain in order to test the students and the test had items measuring student ability in knowledge, comprehension and application indicated.

Table 3.3: Table of Specifications

Contents	Knowledge (30%)	Comprehension (30 %)	Application (40 %)	Total
Plane Shape	3	3	4	10
Quadrilaterals	3	3	4	10
Triangles	3	3	4	10
Regular	3	3	4	10
Total	12	12	16	40

Source: Obeka, 2010

These contents were taught both to experimental and control groups. The experimental groups receive the treatment using problem solving and guided discovery while the control group was taught using lecture method.

3.5.2 Student Geometric Attitude Questionnaire (SGAQ)

The Student Geometric Attitude Questionnaire was pretested and post tested to determine the effect of change in attitude of students after exposure to the guided discovery and problem solving strategies. The instrument was adapted from Kathryn (2006) by the researcher based on the previous studies on student's attitude toward Mathematics, geometry in particular. The instrument was modified to cover the following sub-scales of variables namely: attitude of self and friends towards geometry, classroom environment of geometry, characteristic of the teacher

enjoyment of geometry lesson, interest, anxiety, career interest and attitude towards geometric concept.

The instrument needed to be modified for easier comprehension by the students. For example;

i. I freeze up on an important Mathematics exam.

   Modified as: I became afraid while taking an important geometric exam.

ii. I almost never have gotten shooked up during any school subject test.

Modified as: I almost never had gotten shook up during geometric test. The instrument was then validated using the split half method between odd and even numbers. Positive statements were scored 5,4,3,2 and 1 for SA, A, U, D and SD respectively while the reverse was done for negative attitude items.

3.6 Validation of the Instruments

The content validation of Geometric Achievement Test and Geometric Concepts Attitude Questionnaire were assessed by experts that include the following:

- Mathematics education lecturers of Ph.D status from Mathematics education section, Ahmadu Bello University, Zaria.
- Teachers of Mathematics in the Selected Secondary Schools with B.Ed in Mathematics Education.

These groups of experts were requested to critically examine the instruments to assure its correctness, clarity, appropriateness, readability and standard for JSS II students.

3.7 Pilot Testing

The Pilot study was carried out using the instruments; Geometric Performance Test (GPT) and Geometric Concept Attitude Questionnaire (GCAQ) on 80 JSS of GJSS Dakace in Zaria Local

Government of Kaduna State. The data obtained was analyzed to establish the reliability of the instruments. The instrument was administered first and second occasion with test-retest method within an interval of two weeks, Pearson product moment correlation coefficient statistics was used for analysis.

The pilot study was done to:

i. Find out the characteristics of geometric Achiever test item analysis
ii. Determine the appropriateness of the length of time required to take the test
iii. Determine the appropriateness of the wordiness of GPT
iv. Find the reliability of GPT and SGAQ

From the result of the pilot study, test items found too difficult or too easy were either rejected or re-modified and improved. Also items found to have low level of discrimination were dropped using recommendation of Sambo (2008)

The pilot study revealed that the researcher had to be flexible in the conduct of the treatment. The pilot study enabled the researcher to prepare on what to expect in the main study which was not too different during the conduct of the main study.

Their corrections and observation were fully in cooperated in the final draft. The letters of introduction are attached in the Appendix F.

3.8 Reliability of the Instrument

The instruments Geometric Achievement Test and Geometric Concepts Attitude Questionnaire were pilot tested to determine their reliability. The test retest method was employed for GPT and result analyzed using PPMC calculated to be 0.98. While for SGAQ split half method was used

and the reliability found to be 0.86 using Cronbach alpha. This shows that the instruments used were reliable. Appendix G shows explanation of how the coefficients were arrived at.

3.9 Administration of Treatment

The regular Mathematics teachers of the selected schools were trained by the researcher for the period of two weeks and used as research assistants. Each teacher were given copies of validated lesson packages, copies of two instruments for the study. The 3 groups would be taught using the same geometric concepts; quadrilaterals, angles between lines, triangles and polygons. The treatment would last for 6 weeks with administration of post-test after treatment.

The experimental group I and experimental group II were exposed to problem-solving strategy and guided-discovery strategy while the control group learnt the same concept through lecture method. Immediately after the treatment Geometric Performance Test was given to the 3 groups while Geometric Concepts Attitude Questionnaire was given to group I and II and also the control group as post attitudinal test. Sequential lesson plans developed by the researcher were used by the research assistants matched with their respective teachers guide. The topics were broken down into achievable behavioral objective.

Table 3.4: JSS II Geometry Syllabus

Content	Objectives
Quadrilateral	Different properties of parallelogram, rhombus and kite.
Connection between Quadrilaterals	Sketch and define common quadrilaterals.
Angels between lines	Identify: straight lines, angles, vertically opposite angles, corresponding angles and alternating angles.
Angles in Triangles	Differentiate between triangles; calculate sizes of angles in triangles.
Angles in Quadrilateral	Calculating the sizes of angles of quadrilaterals.
Polygon	Differentiate between types of polygon Calculate sizes of interior angles of a polygon.

Source: ***National Mathematics Curriculum for junior secondary schools, 2014***

A lot of researches have been conducted using different models of problems-solving. PPLS was adopted from Jensen and Finley (1996) for this study. Using this strategy, the teacher explained a concept for a very short period of time, and then pose a problem for the learner to solve. Students were expected to solve the problem individually and afterward discuss similarities and difference in groups

STEP I. Problem is posed to the student relevant to the concept to be taught. The Objectives of this step was to make students become familiar with some geometric concepts

STEP II Students were allowed to think and solve the problem presented individually on paper. The purpose of this step was to assist the students to make use of manipulative skills geometric lessons

STEP III Students discuss similarities and differences of their answers with a partner sitting next to him/her. The purpose of this step is to encourage all learners get involved in the study to participate actively. It will also encourage the students to accept the views of others while doing group work

STEP IV Students shared their ideas and findings together. The purpose of this step was to assist the learners to listen to the view of others for a valid and reliable conclusion. Several teaching aids were used for proper lesson delivery during the lesson, to enhance students understanding

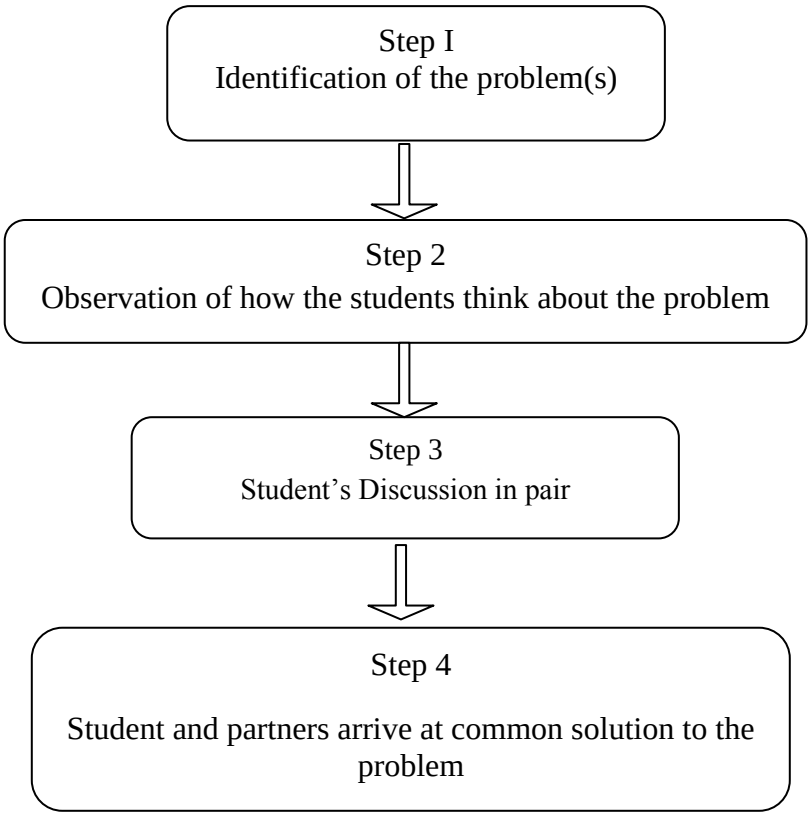


Figure 3.2: Adopted Flowchart of PPSI from Jensen & Finley (1996)
Teachers' Guide for Guided-Discovery Strategy

This strategy focused on student's needs, abilities and interests with the teacher as a facilitator of learning. Here attention was given to the following:

i. Encourage group activities

ii. Use concrete instructional aids

iii. Organize activity based instruction

iv. Allow students interactions through independent work

v. Encourage asking of questions.

3.10 Procedure for Data Collection

The Geometric Performance Test and the Students Geometric Attitude Performance formed the tools for data collection. The groups mean scores for each of these test were calculated and recorded. Also, the mean scores of boys and girls in each group and the attitudinal test score before and after experiment as were collected and calculated.

The pre-test and SGAQ were administered in the first week of the experiment to all groups , before the experimental group were subjected to treatment. The teachers of the sampled schools which were trained for both the experimental group of JSS II by the researcher strictly followed the problem solving and guided discovery modules using the lesson note prepared by the researcher. The teaching and administration of the research instrument were carried out with the help of the regular mathematics teachers from the various sampled schools so as to prevent the students from being agitated

3.11 Procedure for Data Analysis

This section explained the procedure for the statistical analysis used to arrive at decisions for each research questions and the null hypothesis. After the scripts were marked by the researcher, the students' mean performance score of the post test and attitude ranking scores of the SGAQ of all the students were obtained as well as male and female score in each group. The research questions were answered using descriptive statistics of mean and standard deviation, while ANOVA, ANCOVA and kruskal Waliis test were used to test the hypotheses, the following null hypothesis were formulated and tested at $P \leq 0.05$ level of significance:

H_{O1} there is no significant different among JSS students in geometric mean performance score when exposed to Problem Solving and Guided Discovery strategies and those taught using lecture method. The factor variable group were divided while the test variable

performance is a quantity variable, hence the appropriate statistical technique is ANOVA one factor.

H_{02} There is no significant difference between male and female students in mean performance score of JSS students' in geometry when exposed to problem solving and guided discovery strategies and those taught by lecture method. The test variable of mean of JSS in Geometry was computed again using two factors of gender (male & female) and 3 groups (problem solving, guided discovery and lecture) using ANCOVA

H_{03} There is no significance difference among JSS students' in mean attitude towards geometry when exposed to problem solving, guided discovery and of lecture method. The non-parametric test of Kruska-wallis was used because attitude was in frequency of Likert Scale order while the factor variable of group treatments were three

H_{04} There is no significant difference between male and female JSS students' in mean attitude towards geometry when exposed to Problem solving and guided discovery strategies. Independent T-test was used because it consist of difference between mean scores of two independent samples (male and female) and their attitude toward geometry when taught using Problem solving and guided discovery strategies

H_{05} there is no significant difference between male and female JSS students attitude toward geometry when exposed to only lecture method. Also independent t-test was used since difference between two mean scores of two independent samples (male and female) and their attitude towards geometry when taught using only lecture.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND DISCUSSIONS

4.1 Introduction

The purpose of this study was to investigate the effects of problem solving and guided discovery strategies on Junior Secondary Schools geometric performance and attitude in Kaduna State. This chapter deals with data analysis, results and discussion. The data obtained were analyzed using the statistical package for social sciences (SPSS) computer software. Therefore, in this chapter, analytical summary of results of this research were presented, discussion on the results were also made and presented. Here, the core concern of the entire work was presented with the purpose of providing basis for conclusion and highlighting the study's contribution to knowledge. Therefore, descriptive and inferential analysis are presented in such a way that the research questions are answered and the hypothesis tested thereby paving way for decision making using findings from the literature reviewed.

4.2 Data Analysis and Result Presentation

Research Question 1:

The mean performance scores and standard deviation of guided discovery, problem-solving instructional strategies and lecture method of teaching the group raised in the research questions are presented. Table 4.1 and 4.2 present pre-test result of the mean scores, standard deviation and mean difference in problem solving, guided discovery and lecture method group used in the research question on junior secondary school students' mean scores, attitude scores and standard deviation toward geometry.

Table 4.1 Summary of Pretest Mean and Standard Deviation Among JSS

Instructional methods	N	Mean	S.D	Mean Diff
P/S	120	27.61	10.03	0.8
G/D	112	28.26	10.02	0.65
Lecture	149	28.41	10.00	0.15
Total	381			

Table 4.1 reveals the means score, standard deviation and mean difference in the pre-test. The mean scores were 27.61, 28.26 and 28.41 while the mean differences were 0.8, 0.65 and 0.15 for the P/S, G/D and the lecture method respectively.

Table 4.2 Summary of Pre-Test Means Attitude towards Geometry among JSS

Group	N	Mean Rank	Mean Diff
P/S	120	99.64	0.20
G/D	112	98.53	0.51
Control	149	98.84	0.31
Total	381		

Table 4.2 Shows that the mean ranking attitude scores towards geometry were 99.04, 98.53 and 98.84 while the mean difference were 0.20, 0.51 and 0.31 for P/S, G/D and lecture method in the pretest

Table 4.3: Summary of Post Test Mean Scores and Standard Deviations among JSS

Group	N	Mean	S.D	Mean Diff
P/S	120	45.47	15.94	5.87
G/D	112	42.56	17.22	3.21
Control	149	39.60	15.79	2.32
Total	381			

Table 4.3 shows the mean performance scores, standard deviation and mean difference of students when taught using P/S, G/D and lecture method among JSS. Their mean performance scores were 45.47, 42.56, and 39.60 respectively

4.3 Hypothesis Testing

In chapter one, five hypotheses were formulated with the view to answering the research questions raised. In this section attempts were made to test the hypotheses at 0.05 level of significance

H_{O1} There is no significant different among JSS students in geometric mean performance score when exposed to Problem Solving and Guided Discovery strategies and those taught using lecture method. The factor variable group were divided while the test variable performance is a quantity variable, hence the appropriate statistical technique is ANOVA one factor.

Table 4.4: Summary of ANOVA on Mean Difference Among JSS students

Variable	Sum of Square	DF	Mean square	F.Ratio	F-Critical	P-Val
Between group	2300.16	2	1150.08	4.34	2.60	0.01
Within group	100123.12	378	264.87			
Total	102423.28	380				

Calculated: P<0.05, Cal F-Ratio > 2.60 at df 2,378

Result of the one way ANOVA statistics in Table 4.4 reveals that significant difference exist among the 3 group of students'. The reason for this is that the calculated significance for P-Vale of 0.01 is lower than 0.05 alpha (α) level of significance while the Calculated F-Ratio value of 4.34 is higher than f Critical value of 2.60. This implies that the null hypothesis which states that there is no significant difference among JSS students' in geometry mean performance score when taught using P/S& G/D and lecture method is hereby rejected. Hence table 4.5 presents summary of post hoc test using Scheffe multiple comparison test on mean difference in performance score

Table 4.5: Summary of Post Hoc Scheffe Multiple Comparison test on mean difference

	Group (i)	Group (j)	(i - j) Mean Diff.	Std. Error	P-Value
	Control	P/S	-5.87*	1.99	0.01
		G/D	-2.95	2.01	0.34
		Control	5.87*	1.97	0.01
Scheffe	P/S	G/D	2.91	2.11	0.39
	G/D	Control	2.95	2.01	0.34
		P/S	-2.91	2.11	0.38
	Control	P/S	-5.87*	1.97	0.001
		G/D	-2.95	2.01	0.14
		Control	+5.87*	1.97	0.001
LSD	P/S	P/S	+2.91	2.11	0.16
	G/D	Control	2.95	2.01	0.14
		G/D	-2.91	2.11	0.16

*The mean difference is significant at P<0.05 level

Details of the Post Hoc Using Scheffe multiple comparison test pair used in Table 4.5 reveals that the mean performance between P/S and control group is significant as the calculated (p) value of 0.001 is less than the 0.05 α value of significance. However, there is no significant mean performance between P/S and G/D strategies as the calculated value of 0.17 is greater than 0.05 α level of significance

Table 4.6: Summary of posttest mean Scores and Standard Deviation Between Male and Female

Group	Sex	N	Mean	S.D	Mean Diff
P/S	Male	64	43.67	17.91	2.91
	Female	56	47.53	13.21	2.95
G/D	Male	50	45.78	18.22	2.95
	Female	62	39.96	16.05	-2.91
Control	Male	81	36.58	14.98	-5.75
	Female	68	43.20	16.09	-2.96

Table 4.6 shows the mean performance score between male and female in the three treatment group in geometry among the JSS student in P/S strategy, the mean performance of male and female students were 43.67 and 47.53 respectively. However in G/D the mean performance of male and female students were 45.78 and 39.96 respectively while in lecture method, the mean performance of male and female were 36.58 and 43.20. This result implies that there is significant difference in the performance of the three groups of students when exposed to the P/S, G/S and lecture method.

H_{02} There is no significant difference between male and female students in mean performance score of JSS students' in geometry when exposed to problem solving and guided discovery strategies and those taught by lecture method. To test this hypothesis, Analysis of Covariance (ANCOVA) was used. The result obtained is shown in Table 4.7

Table 4.7: Summary of ANCOVA between Male and Female JSS Performance Scores

Source	Type III Sum of Square	DF	Mean Square	F	p-Value
Corrected model	5303.89 [a]	5	1060.77	4.09	0.01
Intercept	681919.21	1	681919.21	26.33	0.001
Sex	226.31	1	226.31	0.87	0.35
Group	2169.38	2	1084.69	4.18	0.01
Sex* Group	2582.81	2	1291.40	4.98	0.001
Error	97119.39	375	258.98		
Total	784897.00	381			
Corrected Total	102423.29	380			

Significant at P<0.05 R squared =0.05 (Adjusted R Squared =0.03)

Result of Table 4.7 of the ANCOVA shows that there exist significant mean difference between male and female performance score in Geometry when exposed to P/S and G/D strategy and those taught using lecture method because the calculated value of intercept 0.001 is less than the significant value of 0.05. However on individual analysis of mean performance score in geometry on the two factors (Sex and group) significant difference exist when exposed to P/S

and G/D and those exposed to lecture method as the computed P-value 0.01 is less than 0.05, but there is no significant difference between male and female mean performance score in Geometry as the computed P-Value of 0.35 is greater than 0.05 α levels of significance. Therefore, the null hypothesis which states that male and female mean performance in geometry when exposed to P/S, G/D and those of lecture method was hereby rejected. Hence Table 4.8 presents a summary of scheffe post hoc test of multiple comparison between male and female student performance score when exposed to P/S, G/D and those exposed to lecture method

Table 4.8: Summary of Post Hoc Scheffe Multiple Comparison tests on Mean difference

	Group (i)	Group (j)	(i - j) Mean Diff.	Std. Error	P-Value
	Control	P/S	-5.87*	1.99	0.01
		G/D	-2.95	2.03	0.34
		Control	5.87*	1.99	0.01
Scheffe	P/S	G/D	2.91	2.13	0.38
	G/D	Control	2.95	2.03	0.34
		P/S	-2.91	2.13	0.39
	Control	P/S	-5.87*	1.99	0.001
		G/D	-2.95	2.03	0.14
		Control	+5.87*	1.99	0.001
LSD	P/S	G/D	+2.91	2.13	0.17
	G/D	Control	2.95	2.03	0.14
		P/S	-2.91	2.13	

Based on Observed means, the error terms is Mean square (Error) = 258.98
The mean difference is significant at P<0.05

Table 4.8 shows details of the post Hoc using Scheffe multiple comparison test pair wised results between Sex and group treatment reveals that the means between control group and P/S group is significant as the calculated P-Value of 0.01 is less than the 0.05 alpha value of significance and vice versa. However, there is no significant mean difference between P/S and G/D strategies as the calculated value of 0.38 is higher than 0.05 α level of significance.

Table 4.9: Summary of Post Test Mean Attitude score among JSS students

Instructional Strategies	N	Mean rank	Mean Diff
P/S	120	259.98	5.87
G/D	112	205.5	1.62
Lecture	149	39.60	2.32
Total	381		

Table 4.9 shows non-parametric statistics used in measuring attitude level of JSS students in the three group showing mean difference of 8.87, 1.62 and 2.32 by students in P/S, G/D and lecture method respectively

H_{03} There is no significance difference among JSS students' in mean attitude towards geometry when taught using problem solving and guided discovery strategies and those taught using lecture method.

Table 4.10: Summary of Kruskal-Wallis Test of mean attitude score towards Geometry

Groups	N	Mean Rank	H-Value	DF	P-value
EXP I	120	259.98			
EXP II	112	205.5	103.74	2	0.001
Control	149	39.60			

*Significance at P<0.05 level

Table 4.10 shows the mean attitude score of the 3 group of JSS students' attitude toward geometry. The result shows that significant difference exist among the 3 groups of students in tier attitude toward geometry. This is because the calculated significant value of 0.001 is less than the 0.05 α value of significance. There mean attitudinal ranking were 250.98, 205.58 and 124.48 by students in P/S, G/D and lecture method respectively. This shows that students in P/S have the highest means ranking attitude toward geometry than the rest of the two groups. Therefore, the null hypothesis which states there is no significant difference among JSS in their attitude towards geometry when exposed to P/S, G/D and lecture method was rejected implying that the problem-solving and guided Discovery strategy had a positive influence on the attitude of students in geometric class.

Table 4.11: Summary of Post Hoc LSD multiple comparison test on mean attitude difference

	Group (i)	Group (j)	(i - j) Mean Diff.	Std. Error	P-Value
	Control	P/S	-45.63*	1.99	0.001
		G/D	-27.49*	2.03	0.001
		Control	45.63*	1.99	0.001
LSD	P/S	G/D	18.13*	4.00	0.001
		Control	27.49*	3.80	0.001
	G/D	P/S		1.99	0.001
		P/S		2.03	0.001
	Control	G/D		2.13	0.001
		Control		2.03	0.001
	P/S	G/D	18.13*	4.00	0.001
		Control	27.49*	3.80	0.001
	G/D	P/S	-18.13*	4.00	0.001

*Mean difference is significant at P<0.05 level

Details of the post Hoc using LSD multiple comparison test pair wised in table 4.11 reveals that the mean attitude difference of P/S and G/D is significant at P- value of 0.001 which is less than 0.05 α value of significance. There is also Significant mean attitude ranking difference between P/S and lecture method of teaching as the calculated value of 0.00 os less than 0.05 α levels of significance. Hence the mean attitude ranking difference exists among the entire groups.

Table 4.12: Summary of Post Test Mean Attitude and Standard Deviation between Male and Female

Variable	Gender	N	Mean	Standard Error	Mean Diff
Attitude towards geometry	Male	114	87.39	31.77	4.29
	Female	18	91.68	40.15	

Table 4.12 shows the attitude mean score between male and female in the two groups P/S and G/D towards geometry. Their computed mean scores towards geometry were 87.77 and 91.68 by male and female respectively

H_{04} There is no significant difference between male and female JSS students' in mean attitude towards geometry when exposed to Problem solving and guided discovery strategies.

Table 4.13: Summary of t-test between Male and Female Mean Attitude towards Geometry

Variable	Gender	N	Mean $\bar{X}$	Standard Error	DF	t-cal	t-crit	p-value
Attitude towards geometry	Male	114	87.39	31.77	2.97	230	1.96	0.36
	Female	18	91.68	40.15	3.69			

P-cal>0.05, t-cal<1.96 at Df 230

Table 4.13 of the independent sample difference between male and female students' attitude towards geometry when taught using P/S and G/D. this is because the calculated value of P of 0.36 is greater than 0.05 α level of significance when the t-Cal of 0.36 is lower than 1.96 t-critical value at DF 230. Hence, the null hypothesis which states that there is no significant difference between male and female students' attitude towards geometry when taught using P/S and G/D strategies is rejected. This implies that the P/S and G/D strategies were good for both male and female.

Table 4.14: Summary of Mean Attitude score and standard Deviation between male and female

Variable	Gender	N	Mean $\bar{X}$	S.D	Standard Error	Mean Diff
Attitude towards geometry	Male	81	57.54	19.43	2.15	
	Female	68	46.92	21.71	2.63	10.61

Table 4.14 shows the mean score, standard deviation and mean difference between male and female JSS students attitude toward geometry when taught using only lecture method. Their mean attitude scores were 57.54 and 46.92 by male and female respectively. The mean difference between the two mean score was 10.61

$H_{05;}$ there is no significant difference between male and female JSS students attitude toward geometry when exposed to only lecture method.

Table 4.15: Summary of t-Test Between Male and Female Attitude towards Geometry

Variable	Gender	N	Mean	S.D	Standard Error	DF	t-cal	t-crit	p-value
Attitude towards geometry	Male	81	57.54	19.43	2.15	157	3.14	1.96	0.001
	Female	68	46.92	21.71	2.63				

Calculated P< 0.05, Calculated T>1.96 at DF 157

Table 4.15 results of the independent sample t-test statistics shows that significant difference exist between male and female JSS students' attitude toward geometry when taught using only lecture method. This is because the calculated significance (P) value of 0.001 is lower than 0.05 Alpha level of significance while the calculated t- Value of 3.14 higher than 1.96 critical to value at DF 157. Hence the null Hypothesis which state that there is no significant difference between male and female JSS students attitude towards geometry when taught using lecture method is hereby rejected. This implies that male had higher mean attitude scores toward geometry than female counter parts when taught using only lecture method.

4.4 Summary of Findings

In this study the following findings were made:

1. There was significant difference between the students taught using problem solving, guided discovery instructional strategy and those taught with lecture method. But no significant difference exists between the group exposed to problem solving and those taught with guided discovery instructional strategies. Therefore, in this case, the null hypothesis is retained.

2. There was significant difference between male and female subjects in their performance when taught with problem solving strategy. Also, no significant difference exists between the male and female students taught with the guided discovery strategy. This implies that gender has no significant effect on student's performance in geometry when exposed to problem solving and guided discovery strategies.
3. There was significant difference between the students' attitude in geometric concept before and after exposure to problem solving and guided discovery strategies.

4.5 Discussion of the Results

The results of the study are discussed below:

The analysis in Table 4.4 shows that there is a significant difference in academic performance of the students in their post-test score. The results were further subjected to post hoc test to ascertain which group achieved significantly higher. From Table 4.5, there is significant difference between the group taught with problem solving strategies and those taught with lecture method . Similarly, the group exposed to guided discovery strategy show significant difference with their counterpart taught with lecture method only. This finding is supported by Mwelese and Wanjala (2014) who stated that through adoption of effective instructional approach performance in Mathematics could be highly improved.

However, in comparison of mean scores of students exposed to problem solving and those taught using guided discovery showed no significant difference. Thus, the null hypothesis is retained. This finding is in agreement with works of Case et al, 2003; Rule and Hillgan 2006, Kurumeh and Achor (2008) which maintained that hands on and minds on activities have positive effect on improving students academic performance. Also the finding is consistent with that of Etukudo, 2000; Folorunso and Nwosu, 2000; Usman (2008). The non-significant

difference found between EXP 1 AND EXP 2 groups implies that problem solving strategies is as effective as guided discovery strategy in teaching geometry. This is supported by Tsoho (2011); Mohd (2012); Khadala (2014) who found that student centered strategies is effective in students' performance in geometry.

The reason for the difference in the achievement of the experimental groups and the control group is not far fetch from the fact that students were more likely to interact in an active way with the problem solving and guided discovery strategies. Takawira and Matthias (2010) maintained that lecture method of teaching alone cannot fully develop students' ability to grasp Basic Science concepts. Also Mwelese and Nwajala (2014) maintained that the lecture method does not enhance students' participation, team work and peer interactions and so, the performance of students taught through the lecture method would certainly be discouraging.

The other hypothesis is centered on gender. In this regards, the results in Table 4.6 and 4.7 shows that there is no significant difference between the males and females in their performance when exposed to problem solving strategies. Also, no significant difference among the male and female when taught using the guided discovery strategy.

The use of the either problem solving or guided discovery strategy does not show any significance between male and female in either of the groups. This implies that the problem solving strategy is as effective as the guided discovery strategy in the achievement of both sexes. This is supported by the findings of Brown and Abell (2007); Clark (2009); Akinyemi Foloshade (2010); who investigated the use of problem solving and guided discovery and maintained that each of this strategy is capable of producing same results.

Different teaching methods draw attention to different learning outcomes Samuelson (2008). According to Samuelson (2008) students who work in problem solving classes and

guided discovery classes were exposed to a higher level of reasoning and they accepted this reasoning as valid.

Contrarily, in the control group were the lecture method is employed; students generally interacted with the teacher which lead to a lower achievement. The results of hypothesis on attitudes shown in Table 4.9 and 4.10 indicated that the students' attitude show significant difference between before and after exposure to treatment. The opportunity for active participation by the leaner provided for by the problem solving and guided discovery based instructional strategies seems to arouse interest and consequently resulted into positive attitude towards geometry. The importance of a positive attitude towards a subject leading to high academic achievement has been emphasized by experts such as: Fraenkel and Wallen (2000); Bergeson et al (2000); Bolaji (2005); Aiyede (2007); Kadala (2014) have argued that a positive attitude correlates positively with students' achievement. Credible numbers of research outcomes have shown that the type and quality of instructional strategy are very important variables affecting students' attitude towards geometry and Mathematics (Pickens, 2005; Rasha et al, 2007, Yara 2009, Eniageju, 2010, Mohammed, 2012; Kadala 2014). In addition, the result agrees with findings of Olatoye (2001); Osborne (2009), Auwal (2014) who in assessing the attitudes of some science students towards science and impact of computer assisted learning instructions in Mathematics found that students' mean attitude towards Science and Mathematics was significant while gender and class level of students did not significantly influence students' attitude towards science. This discussion implies that problem solving and guided discovery strategies showed significant change in students' attitude and so the guided discovery and problem solving instructional strategies could therefore be very essential in the teaching and learning of geometry at the Junior Secondary School level most specifically in Kaduna State Schools.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study investigated the effects of problem solving and guided discovery strategies on geometric performance and attitude of secondary school students in Kaduna State Nigeria. Thus, in this chapter, the main variables investigated were students' performance, their attitude and gender in geometry using Problem solving and Guided discovery strategies compared with the lecture method. Four conclusions were arrived at while the research arrived at five recommendations which could be of use to the Kaduna State Educational Setup. This chapter is presented under the following headings:

5.2 Summary

5.3 Conclusion

5.4 Recommendations

5.5 Contribution to Knowledge

5.6 Limitations of the Study

5.7 Suggestions for Further Studies

5.2 Summary

In this section, major findings of the study were discussed, conclusions were reached and recommendations were made. The findings of the study and limitation were highlighted and suggestions for further research were also provided. The study considered a sample of 381 Junior Secondary school Students with an average age of 14 years old.

By random assignment to treatment, the sample was formed into three groups, two experimental groups and one control group. A pretest and posttest items were developed and were tested for validity and reliability through pilot study. All the groups were taught the same selected topics for six weeks, with the pretest given before the treatment began, while the posttest items were administered at the end of the treatment

The literature reviewed seems to suggest that some specific factors like teacher related factors and the student's related factors plays significant role in determining student attitude toward geometry as well as their level of attainment in the subject (Driver, 2000). The teacher related factor of instructional strategy the singular most important variable in deciding the attitude as well as performance of a learner in a subject (Bolaji, 2005).

The aim of problem-solving and Guided discovery strategy is to build up confidence and ability of learners to solve all kinds of problem. This is because these strategies share some of he characteristics of the scientific method and are said to be integral to thinking and working cooperatively (Aiyede, 2007). To ensure answers to the research questions and testing of the null hypothesis two main instruments were used which included the geometric performance test and the student attitude geometry Questionnaire.

The data obtained were analyzed using the Statistical Package for Social Science (SPSS) computer Software. Appropriate statistics were used to analyze research questions and also null hypothesis.

Conclusively, when knowledge is presented to the learner in a manner that he/she could be engaged in the learning activities, learning is more meaningful which leads to improve performance and positive influence on attitude.

5.3 Conclusion

The findings of this study led to the following conclusions:

1. Instructional strategies that teachers use in teaching geometry have significant effects on student performance in geometry.
2. The use of either problem solving or guided discovery can facilitate learning of geometry in the junior secondary schools.
3. Geometric performance test according to gender reveals that both sexes in the experiment I, II groups show no significant effect when exposed to treatment.
4. The finding on students' attitude after exposure to problem solving and guided discovery strategies showed influence on their attitudes. The students enjoyed teaching and learning of geometry using problem solving and guided discovery strategies, since these allowed them to have interaction, discussion before coming to an acceptable possible solution of a given problem. These two strategies kept every learner very active and involved at every stage of finding solutions to problems. Thus attitude of learners is favorable and this in turn improved their geometric performance.

Therefore, either the problem solving or the guided discovery instructional strategies could be used by Mathematics teachers in the teaching of geometry.

5.4 Recommendations

In this study, some recommendations were made based on the findings and conclusions. They are as follows:

1. The teaching of geometry at the junior secondary school should be conducted in a manner that students will effectively understand and learn the concept taught. It should respect

the views and ideas of the students since students' participation plays greater role in learners' performance.

2. The fact that higher mean was recorded in students' performance through the use of problem solving strategy, calls for teachers to acquaint themselves with the characteristics of this teaching method with a view to enhancing students performance and outcomes in learning. This could be done through seminars, conferences and workshops to be organized by State government and professional bodies.

3. The findings of this study had also generated the need for further research of this type to be undertaken to replicate the present study using a wider geographical area.

4. From time to time, the State government and the Local Education Authority should liaise and organize workshops for Mathematics teachers to educate them on the need for the use of various instructional strategies. This is to complement the efforts of the Millennium Development Goals (MDGs) for retraining Mathematics teachers.

5.5 Contributions to Knowledge

The study has contributions to knowledge as follows

1. The study has brought with it Problem Solving and Guided Discovery instructional strategies teaching Modules; which were used in teaching geometry learning activities that were developed. This is capable of contributing in no small measure to knowledge in the area of research. Consequently students and researchers will find this work useful for further research.

2. In various studies, attitudinal changes were left out and was used in this study and found that positive attitudinal change was attained using Problem Solving and Guided discovery.

5.6 Limitations of the Study

In this study, some issues were considered as limiting factors

1. Issues associated with data collection procedure were of great importance. This study was limited to only three Junior Secondary Schools in the whole of Kaduna State
2. Also, the time allocated for each lesson in JSS 2 was only forty minutes which was not enough for most especially the guided discovery strategy
3. Because more time was needed in the applicative aspect of the questions, the number of questions as indicated in the applicative domain was reduced.

5.7 Suggestions for Further Studies

In concluding this study, the following were suggestions for further studies on problem solving and guided discovery strategies:

1. The effect of problem solving and guided discovery instructional strategies on other branches of Mathematics which are commonly called ‘difficult’ by students and even teachers sometimes among junior secondary school students.
2. The feelings of junior secondary school students could further be investigated together with the feelings of teachers when the problem solving and guided discovery strategies are used.
3. Similar research could be conducted in other geographical locations such as comparing urban and rural junior secondary school students.

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APPENDICES

APPENDIX I

Lesson

Unit: Geometry

Lesson Topics: Consist of 6 Lessons

1. Plane shapes (quadrilaterals): differentiate properties of:

   Parallelogram

   Rhombus

   Kite

2. Connections between quadrilaterals

3. Angles between lines: identify the following

   i. Straight line angles

   ii. Vertically opposite angles

   iii. Corresponding angles

   iv. Alternate angles

4. Angles in triangles: difference between types of angles

   i. Equilateral

   ii. Isosceles

   iii. Scalene

   iv. Right angles

   v. Calculating the sizes of angles

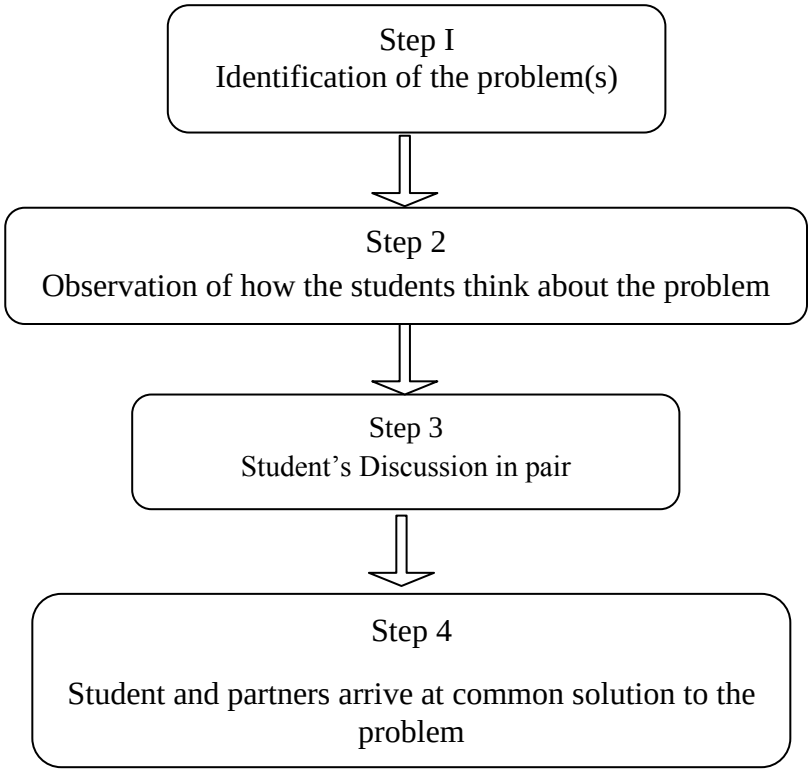
5. Angles in a quadrilateral: calculating sizes of angles of quadrilateral

6. Polygons: different types of polygons calculate sizes of angles of the interior angles of polygon.

Lesson Plan on Problem Solving Strategy

Teacher's guide on problem solving strategy.

Problem solving is an approach that maintains constant flow going between teacher and the students. Lesson situations are structured where students face questions, define it in specific terms and evaluate solutions. Emphasize process, the sequential order in which events occur through using practical examples to guide students.



Lesson 1

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Plane Shapes (Quadrilaterals)

Behavioral Objective: By the end of the lesson students should be able to differentiate properties of parallelogram, Rhombus and Kite.

Teaching Aids: charts, cut materials, Mathematics set

Instructional Procedure: To guide students to understand the problem, in their groups students use ruler and Set Square to draw parallel lines. Students draw another pair of parallel lines so that both cross the first pair. The Shape inside the four lines is a parallelogram. Students explain a parallelogram as a quadrilateral which has opposite sides parallel.

Step II: Students are to use the cut material to cut the shape of a diamond, a playing card, the shape is Rhombus. It is a quadrilateral which has all four sides equal.

Step III: Students further uses the charts to show how a kite looks and then explain s that, it is quadrilateral in which one diagonal is a line of symmetry in their groups.

Step IV: The teacher further uses the charts to show how a kite looks and then explains that it is a quadrilateral in which one diagonal is a line of symmetry.

Evaluation: students perform the following exercises by:

i. identifying the shapes (ii) analyzing their properties (iii) carrying out the work and then (iv) look back to comparing their difference.

1. Write down three differences between Rhombus and a Parallelogram.

2. Write down three differences between a Kite and a Rhombus.

Lesson 2

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Plane Shapes (Quadrilaterals)

Behavioral Objective: By the end of the lesson students should be able to sketch and define quadrilaterals.

Aids: Charts and cut materials.

Instruction Procedure Step I: Students uses sketches on charts of the following quadrilateral and explain some of their properties each other: (i) Trapezium (ii) Parallelogram (iii) Rhombus (iv) Kite (v) Rectangle (vi) Square

Step II:Teacher leads the students to define each shape as follows by asking the students to look at a figure and deduce its meaning from its properties;

i. A quadrilateral is a plane shape with four sides.

ii. A trap is a quadrilateral which has one pair of opposite side parallel.

iii. A parallelogram is a quadrilateral which has two pairs of parallel sides.

iv. A Rhombus is a quadrilateral with four sides equal in length.

v. A kite is quadrilateral which has one diagonal as a line of symmetry.

vi. A rectangle is a quadrilateral in which each angle is a right angle

vii. A square is a rectangle with all four sides equal in length.

Step III: Students discuss between themselves and infer the following connections using the charts at their disposal

i. All squares are rectangles but not all rectangles are squares.

ii. Squares, rectangles and rhombus are special parallelogram but there are many parallelograms that are not square, rectangles etc.

iii. All rhombuses are kites

iv. All squares are kites, not rhombus.

v. But all kites are not rhombuses

Evaluation: students are to write and sketch 2 shapes which are examples of 1) Trapezium 2) parallelogram 3) kite

Lesson 3

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles between lines

Behavioral Objectives: By the end of the lesson students should be able to identify and calculate the sizes of angles on:

i. Straight lines

ii. Vertically opposite angles

iii. Corresponding angles

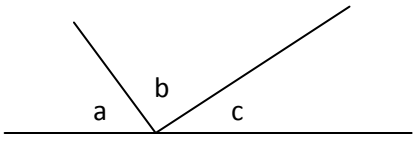
iv. Alternate angles

TeachingAid: Ruler, Protractor, Chalkboard

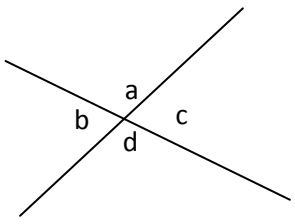
Technique: Refer to teacher's instructional guide

Instructional Procedure:

Step I: Students are to use ruler and a protractor to draw and measure angles in the following fig. and also add the total, this will establish the theorem that the sum of angles on a straight line is 180^0.



Step II: Students do the same as above to establish that vertically opposite angles are equal between themselves



Step III: Students are to draw two parallel lines with a transversal as in the following figures.



Hence, students measure angle a and b which are corresponding similarly c and d which are alternate.

Step IV: are to express within themselves using the charts and deduce the following in their own way

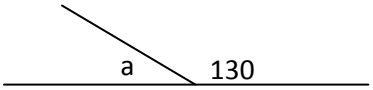
i. Vertically opposite angles are equal

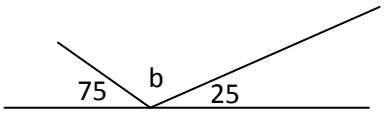
ii. Corresponding angles are equal

iii. Alternate angles are equal

Thus, the students are to use the rule to calculate the values of the marked angles in the following figures with their partner

(b)





Solution:

$a + 130^0 = 180$ (angles on a straight line)

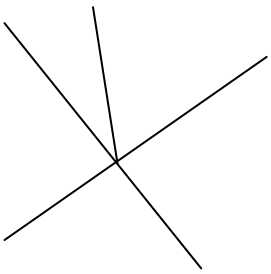
$a = 180 - 130 = 50^0$

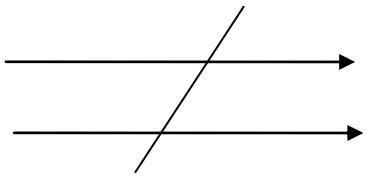
$25 + b + 75 = 180$ (angles on a straight line)

$b = 180 - 100 = 50^0$

Evaluation: Students are to fix any letters as angles in the their groups and then calculate the missing angles in the figure (i) and (ii)

(ii)





Lesson 4

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a triangle

Behavioral Objectives: By the end of the lesson students should be able to (i) differentiate between kinds of triangle (ii) calculate the sizes of angles of

Teaching Aids: Setsquare, ruler, protractor, charts

Procedure:

Step I: Students uses the ruler and the protractor to construct different kinds of triangles in their group and explain their differences.

Step II: Students are to discuss the various types of triangle using the idea of their different types using the charts available to them as follows

i. Equilateral Δ s has all the sides and angles to the same. Each angles is 60^0

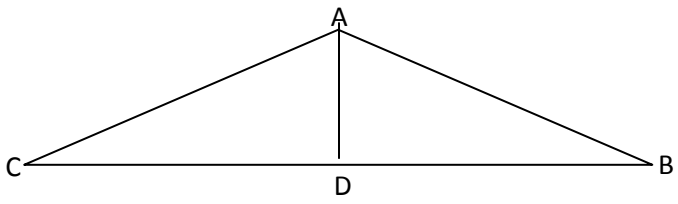
ii. Isosceles Δ has 2 sides and 2 angles equal. The two equal angles are called the base angles

iii. Scalene triangle has all 3 sides and angles different

iv. Right angled triangle is one in which one angle is right angled.

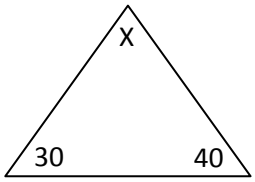
Step III: Students are to use the idea of tearing of the 3 angles of a triangle to show that: the sum of the angles in triangle is the same as angle on a straight line which is 180^0.

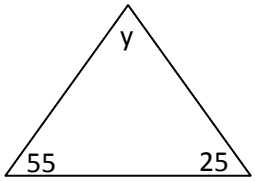
Step IV: students uses the above ideas to find the lettered angles in the following figure with reasons students are to discuss and fix different degree and missing alphabetand calculate presenting outcome from their various group



Evaluation: Students are to find the sizes of the lettered angles in the following figures with reasons as exercise.

(ii)





Lesson 5

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a quadrilateral

Behavioral Objectives: By the end of the lesson students should be able to calculate sizes of angles of quadrilateral

Teaching Aids: Sketches on the board and mathematical set.

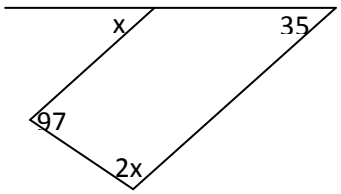
Procedure:

Step I: Students uses the idea of dividing quadrilateral into 2 triangles by drawing its diagonal, discussing with their partners that the sum of angles in each triangle is 180^0. Thus allowing them to deduce sum of angles in a quadrilateral is 360^0 in their group using charts

Step II: Student are to draw any quadrilateral and divide it into 2 and use protractor to measure each of them to establish that the sum of any quadrilateral is 360^0.

Step III: Student uses the above idea to calculate the missing value figure, hence find the values of the other two angles in the same figure.

Step IV: Students uses the above idea to calculate the value of X in the following figure; hence find the values of the other two angles in the figure as example.



Solution:

The 4^{th} angle = 180 – x (straight line)

$(180 – x) + 2x + 2x + 97 + 35 = 360^0$ (sum of angles in a quadrilateral)

$2x – x + 180 + 97 + 35 = 360$

$x + 312 = 360$

$x = 360 – 312 = 48^0$

$180 – x = 180 – 48 = 132$

The other two angles of the quadrilateral are 96^0 and 132^0

Evaluation: Students are to Calculate the 4^{th} angle of quadrilateral whose other three angles are; (i) 100, 60, 80 (ii) 109, 71, 09 (iii) 58, 117, 122.

Lesson 6

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Polygons

Behavioral Objectives: By the end of the lesson students should be able to (i) differentiate types of polygons (ii) calculate sizes of the interior angles of a polygon.

Teaching Aids: Charts, sketches on the board

Instruction Technique: Teacher's instructional guide

Procedure:

Step I: Students uses different types of polygons on charts and then defined polygon with their pair. Polygons are named after the number of sides they have, on chart

Triangle	-	3 sides
Quadrilateral	-	4 sides
Pentagon	-	5 sides
Hexagon	-	6 sides
Heptagon	-	7 sides
Octagon	-	8 sides
Nonagon	-	9 sides
Decagon	-	10 sides

Also a regular polygon has all sides and angles equal. Example equilateral Δ s and squares.

Step II:students are to draw a pentagon and use the idea of joining one vertex to all the other vertices to divide the pentagon in triangle. They will find that the number of triangles depending on the number of sides of the polygon. Thus, it will be deduce that for any polygon with n-sides, there will be n-2 triangles. Thus the sum of the angles of an n – sides polygon.

$= (n - 2) \times 180^0$.

Step III: Students uses the above formular to calculate the size of an angle of a regular heptagon as example in their pair groups teaching guiding from group to group.

Solution:

Regular Heptagon has 7 equal sides and angles

S $= (n - 2) \times 180$

$=(7 - 2) \times 180$

$= 5 \times 180 = 900^0$

Since there are 7 sides

Each angle = $\frac{900}{7} = 128.5°$

Step IV: teacher asks students to use the above idea to calculate how many sides have a polygon whose sum of angles is 1980? This is to be done on the board practical exercise with teacher's assistance.

Solution:

Let the polygon have n – sides

$(n - 2) \times 180 = 1980°$

$n - 2 = \frac{1980}{180} = 11$

$n - 2 = 11$

$n = +213 \text{sides}$

Evaluation: teacher asks students to calculate as exercises the size of each angle of a (i) hexagon (ii) decagon.

Lesson Plans for Guided-Discovery Strategy

Teachers' guide for guided-discovery strategy.

This strategy focus on students needs abilities and interests with the teacher as a facilitator of learning. Here attention must be given to the following:

i. Encourage group activities

ii. Use concrete instructional aids

iii. Organise activity based instruction

iv. Allow students interactions through independent work

Encourage asking of questions.

The following are questions that teachers might have

The teacher say to the students "keep thinking|

Students are encouraged

The students are equally applicable to right and wrong answers

Students are treated as partners in the learning process

Students are encouraged through interaction between themselves

Lesson 1

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Plane shapes (quadrilaterals)

Objective: Students should be able to differentiate properties of parallelogram, rhombus and kite.

Instruction materials: Charts, cut materials Mathematics set.

Introduction: Revise the idea and meaning of plane shapes.

Instructional Technique: Refer to the teachers guide.

Instructional Procedure:

Step I: Use the cut material to cut the shape of a diamond playing card. The shape is Rhombus it is quadrilateral which has all four sides equal.

Step II: Use the charts to show how a kite looks. It is quadrilateral in which one diagonal is a line of symmetry.

Step III: Compare the 3 shapes and write down properties shown by each through measurement.

Evaluation: 1) Write down three differences between a Rhombus and a Parallelogram.

2) Write down three differences between a Kite and a Rhombus.

Lesson 2

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: (connection between quadrilaterals)

v: Students should be able to sketch and give definitions of common quadrilaterals

Teaching Aids: Charts, cut materials and Mathematics set

Instruction Technique: Teacher's instructional guide

Procedure:

Step I: Sketches on charts of a (i) Quadrilateral (ii) Trapezium (iii) Parallelogram (iv) Rhombus (v) Kite (vi) Rectangles (vii) Square.

Step II: Define each of the following as:

i. A quadrilateral is a plane shape with four side.

ii. A trapezium is a quadrilateral which has one pair of opposite side parallel.

iii. A parallelogram is a quadrilateral which has two pairs of parallel sides.

iv. A rhombus is a quadrilateral with four sides equal in length.

v. A kite is quadrilateral which has one diagonal as a line of symmetry.

vi. A rectangle is a quadrilateral in which each angle is a right angle

vii. A square is a rectangle with all four sides equal in length.

Step II: Students are to discover the following connections:

i. All squares are rectangles but not all rectangles are squares.

ii. Squares, rectangles and rhombus are special parallelogram but there are many parallelograms that are not square, rectangles etc.

iii. All rhombuses are kites

iv. All squares are kites, not rhombus.

v. But all kites are not rhombuses

Evaluation: Write down 2 shapes which are examples of (i) Trapezium (ii) Parallelogram.

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles between lines

Behavioral Objectives: By the end of the lesson students should be able to identify and calculate the sizes of angles on:

Straight lines

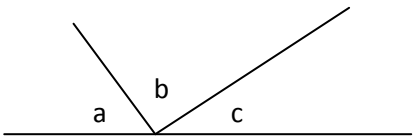
Vertically Opposite

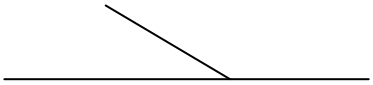
Corresponding

Alternate

Procedure:

Step I: (i) Use protractor to measure the angles in the following figure

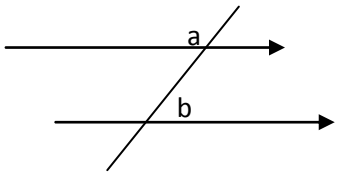


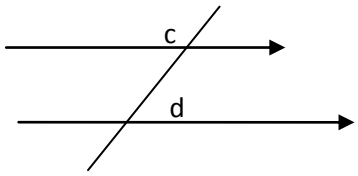


(ii) Add up the total. This will establish angles on a straight equal 180^0.

Step II: Do the same to establish that vertically opposite angles are equal.

Step III: Draw two parallelogram lines with a transversal as in the following figure:





Measure angles a and b which are corresponding. Similarly c and d which are alternate.

Step IV: Note the following:

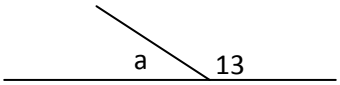
Vertically opposite angles are equal.

Corresponding angles are equal

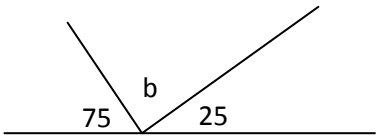
Alternating angles are equal.

Thus, find the values of the marked angles in the following figures.

(a)



(b)



$a + 130^0 = 180$ (angles on a straight line)

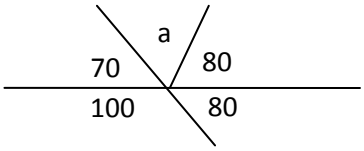
$a = 50^0$

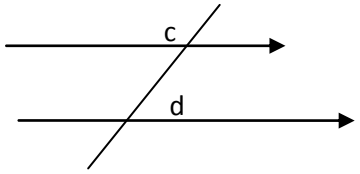
$25 + b + 75 = 180$ (straight line)

$b + 100 = 180$

$b = 180 - 100 = 80^0$

Evaluation: Find the value of the lettered angles in the following figures:





Lesson 4

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a triangle

Behavioral Objectives: By the end of the lesson students should be able to: (i) Differentiate between the kinds of triangles, isosceles, equilateral, scalene and right-angle triangles. (ii) Calculate the sizes of a triangle.

Teaching Aid: set Square, ruler, protractor and board.

Procedure:

Step I: Use the ruler and the protractor to construct different kinds of triangles on the chalkboard showing the differences.

Step II: Define the differences as:

Equilateral Δ s has 3 sides and 3 angles equal. Each is 60^0.

Isosceles Δ is one in which 2 sides and 2 angles are equal. The two equal sides have the base angles.

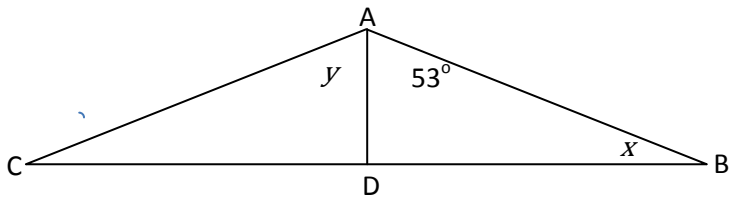
Scalene triangle is one in which 3 sides and 3 angles are all different.

Right-angled triangle is one in which one angle is right-angled.

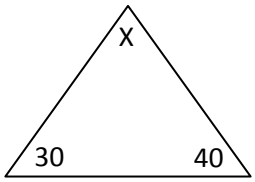
Step III: Use the idea of tearing off the 3 angles of a triangle to show that: the sum of angles of a triangle is the same as angle on a straight line which is 180^0.

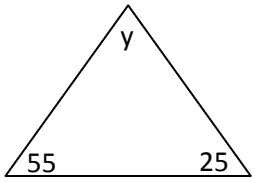
Step IV: Use the above ideas to find the lettered angles in the following figure with reasons.

Solution:



Evaluation: Find the sizes of the lettered angles in the following figures with reasons





Lesson 5

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a quadrilateral

Behavioral Objectives: By the end of the lesson students should be able to calculate sizes of angles of quadrilateral.

Teaching Aid: Protractor, sketches on the chalkboard.

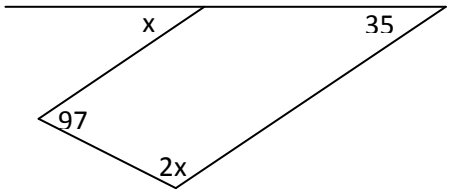
Procedure:

Step I: Use the idea of dividing any quadrilateral into 2 triangles by drawing its diagonal.

Step II: Remind the students that the sum of angles in each triangle is 180^0. Thus the sum of angles in a quadrilateral is 360^0.

Step III: Use protractor to measure each of the angles of any quadrilateral and add all of them to establish that the sum of angles of a quadrilateral is 360^0.

Step IV: Find X in figure, hence the other to angles in the figure.



Solution:

Z = 180 – x (angle on a straight line)

$180 – x + 2x + 35 + 97 = 360^0$

$x + 312 = 360^0$

$x = 360 – 312 = 48^0$

Thus $2x = 2 \times 48^0 = 96^0$

$Z = 180 - x = 180 - 48 = 132^0$

The other two angles of the quadrilateral are 96 and 132.

Evaluation: Calculate the 4^{th} angles of the quadrilateral whose other 3 angles are (i) 100, 60, 80 (ii) 109, 71, 09 (iii) 58, 117, 122.

Lesson 6

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Polygons

Behavioral Objectives: By the end of the lesson students should be able to: (i) Differentiate types of polygons (ii) Calculate sizes of interior angles of polygon.

Teaching Aid: Charts, sketches on the chalkboard

Procedure:

Step I: Define polygon as any figure with straight sides. Polygons are named after the number of sides they have.

Step II: Give examples of polygons (check last strategy)

Step III: Use the idea of joining one vertex to all vertices to divide the polygon into triangles. You will discover that the number of triangles depend on numbers of sides of the polygon. For any polygon with n-sides there will be n-2 triangles. Thus, the sum of the angles of an n-sides polygon

$= (n-2) \times 180^0$

Step IV: Use the above formular to calculate the size of an angle of a regular heptagon.

Solution:

A regular heptagon has 7 equal sides and angles.

S = (n-2) x 180 but n=7

S = (7-2) x 180

$5 \times 180 = 900^0$

Since the angles are 7

Each angle = $\frac{900}{7} = 128\frac{4}{7}$

Step V: Give another example as follows: the sum of angles of a regular polygon is 1980 how many sides has the polygon?

Solution:

Let the polygon have n-sides $(n - 2) \times 180 = 1980^0$

$n - 2 = \frac{1980}{180} = 11$

$n = 11 + 2 = 13$

therefore, the polygon have 13 side.

Evaluation: Calculate the size of each angle of a regular (i) Hexagon (ii) Decagon.

Teacher's Guide for Lecture Method

Students sit passively and watch teacher solves problems on the board and copy with little room for student's involvement. Attention must be paid to the following:

1. Minimal student's interaction
2. Activities are mostly dominated by teacher
3. Little opportunity to ask questions.

Lesson Plan for Lecture Method i.e the Control Group

Method of Teaching: :Lecture Method

Subject: Mathematics

Lesson: 1

Group: Control Group

Class: JSS II

Unit Title: Quadrilaterals

Time: 90 Minutes

Topic: Properties of Quadrilaterals

Reference Book: New General Mathematics JS 2 UBE Edition.

Instructional Materials: Mathematical sets sheets of papers

Behavioral Objectives: By the end of the lesson, students should be able to:

Identify and define parallelograms and rhombus and kite

Recall and describe the properties of parallelogram and rhombus and kite

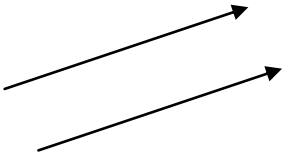
Previous Knowledge: Students have learnt about shapes. They should be able to identify them in pictures and physical shapes.

Lesson Presentation:

Teacher draws 4 sided plane shapes of different sizes on the board. He uses them to assist the students to identify pictures of quadrilaterals and parallelogram.

Teacher then brings out quadrilateral and parallelogram of different sizes made up card board paper for the students to see, touch and play with. Teacher now explains to students properties of quadrilateral; A quadrilateral is any plane shape with 4 sides.

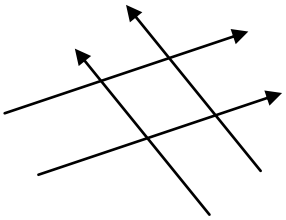
Parallelogram: use a ruler and set-square to draw a pair of parallelogram lines. Example;



Draw another pair of parallelogram lines so that both lines cross the first pair. Example.

The line inside the 4 lines is a parallelogram

.



A parallelogram is a quadrilateral which has opposite sides parallel.

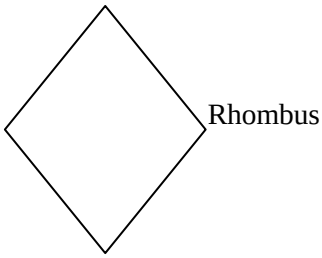
Activity

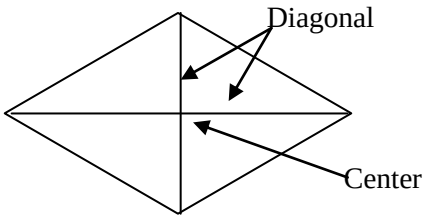
Try to name a few things in your home, class or town which have the shape of a parallelogram.

Draw a parallelogram with at least 5cm long.

Draw a large parallelogram on a sheet of newspaper. Cut out the parallelogram.

Rhombus: The shape of a diamond in playing cards is called a rhombus.





The rhombus is a quadrilateral which has all sides equal.

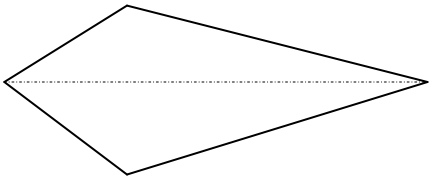
Activity

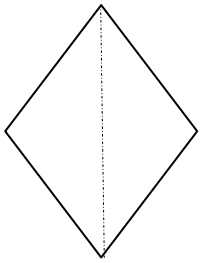
Try to name a few things in your home, class which have shape of rhombus.

How many sides have a rhombus?

How many angles have a rhombus?

Kite: A kite is a quadrilateral in which one diagonal is a line of symmetry.





Step 4: Compare the 3 shapes and write down properties shown by each through measurement.

Evaluation: (1) Write down 3 differences between a rhombus and a parallelogram

(2) Write down 3 differences between a kite and a rhombus.

Lesson 2

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Plain shapes (connection between quadrilaterals)

Objective: Students should be able to sketch and give definitions of common quadrilaterals

Teaching Aids: Charts, cut materials and Mathematics set

Instruction Technique: Follow the guide

Instruction Procedure:

Step I: Sketches on charts of a (i) Quadrilateral (ii) Trapezium (iii) Parallelogram (iv) Rhombus (v) Kite (vi) Rectangles (vii) Square.

Step II: Teacher defines the following:

i. A quadrilateral is a plane shape with four sides.

ii. A trapezium is a quadrilateral which has one pair of opposite side parallel.

iii. A parallelogram is a quadrilateral which has two pairs of parallel sides.

iv. A rhombus is a quadrilateral with four sides equal in length.

v. A kite is quadrilateral which has one diagonal as a line of symmetry.

vi. A rectangle is a quadrilateral in which each angle is a right angle

vii. A square is a rectangle with all four sides equal in length.

Step III: Teacher shows the connections between all quadrilaterals as follows:

i. All squares are rectangles but not all rectangles are squares.

ii. Squares, rectangles and rhombus are special parallelogram but there are many parallelograms that are not square, rectangles etc.

iii. All rhombuses are kites

iv. All squares are kites, not rhombus.

v. But all kites are not rhombuses

Evaluation: Write down 2 shapes which are examples of (i) Trapezium (ii) Parallelogram.

Lesson 3

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles between lines

Behavioral Objectives: By the end of the lesson: students should be able to identify and calculate the sizes of angles on:

Straight lines

Vertically Opposite

Corresponding

Alternate

Teaching Aids: Ruler, protractor, chalkboard.

Instructional Techniques: Follow the guide

Instructional Procedure:

Step I: (i) Use protractor to measure the angles in the following figure



(ii) Add up the total. This will establish angles on a straight equal 180^0.

Step II: Do the same to establish that vertically opposite angles are equal.

Step III: Do the same as above to establish that vertically opposite angles are equal.

(i)



Measure angles a and b which are corresponding. Similarly c and d which are alternate.

Step IV: Note the following:

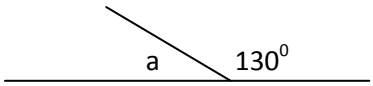
Vertically opposite angles are equal.

Corresponding angles are equal

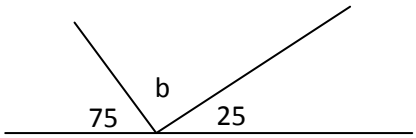
Alternating angles are equal.

Thus, find the values of the marked angles in the following figures.

(a)



(b)



Solution:

$a + 130^0 = 180$ (angles on a straight line)

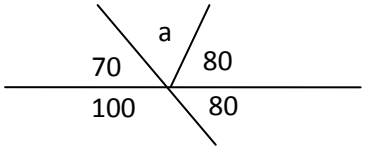
$a = 50^0$

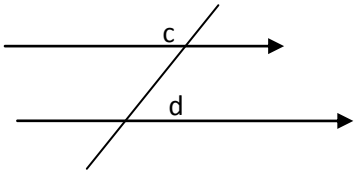
$25 + b + 75 = 180$ (straight line)

$b + 100 = 180$

$b = 180 - 100 = 80^0$

Evaluation: Find the value of the lettered angles in the following figures:





Lesson 4

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a triangle

Behavioral Objectives: By the end of the lesson: students should be able to: (i) Differentiate between the kinds of triangles, isosceles, equilateral, scalene and right-angle triangles. (ii) Calculate the sizes of a triangle.

Teaching Aid: set Square, ruler, protractor and board.

Procedure:

Step I: Use the ruler and the protractor to construct different kinds of triangles on the chalkboard showing the differences.

Step II: Define the differences as:

Equilateral Δ s has 3 sides and 3 angles equal. Each is 60^0.

Isoscele Δ is one in which 2 sides and 2 angles are equal. The two equal sides have the base angles.

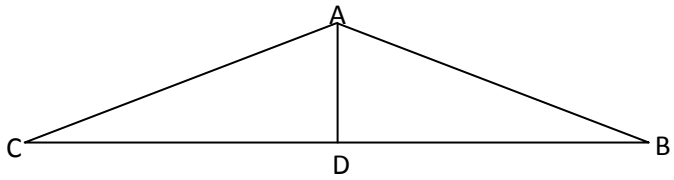
Scalene triangle is one in which 3 sides and 3 angles are all different.

Right-angled triangle is one in which one angle is right-angled.

Step III: Use the idea of tearing off the 3 angles of a triangle to show that; the sum of angles of a triangle is the same as angle on a straight line which is 180^0.

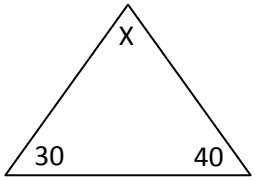
Step IV: Use the above ideas to find the lettered angles in the following figure with reasons.

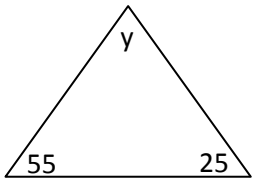
Solution:



In Δ AOC

Evaluation: Find the sizes of the lettered angles in the following figures with reasons





Lesson 5

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Angles in a quadrilateral

Behavioral Objectives: By the end of the lesson: students should be able to calculate sizes of angles of quadrilateral.

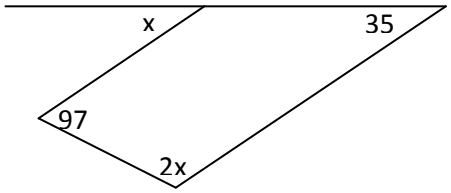
Teaching Aid: Chalkboard, sketches and protractors.

Instructional Procedure:

Step I: The teacher uses the idea of dividing any quadrilateral into 2 triangles by drawing its diagonal; remind student that the sum of angles in each triangle is 180^0. Thus allowing them to deduce that the sum of angles in a quadrilateral is 360^0.

Step II:Teacher asks student to draw quadrilateral and divide into 2 and use protractor to measure each of the angles of the 2 triangles all add all of them to establish that the sum of any quadrilateral is 360^0.

Step III: The teacher uses the above to calculate the value of x in figure.



Solution:

The 4^{th} angle = 180 – x (straight line)

$(180 – x) + 2x + 97 + 35 = 360^0$ (sum of angles in a quadrilateral)

$x + 312 = 360^0$

$x = 360 – 312 = 48^0$

Thus $2x = 2 \times 48^0 = 96^0$

$Z = 180 - x = 180 - 48 = 132^0$

The other two angles of the quadrilateral are 96 and 132.

Evaluation: Calculate the 4^{th} angles of the quadrilateral whose other 3 angles are (i) 100, 60, 80 (ii) 109, 71, 09 (iii) 58, 117, 122.

Lesson 6

Subject: Mathematics

Class: JSS II

Duration: 90 Minutes

Average Age: 15 Years

Topic: Polygons

Behavioral Objectives: By the end of the lesson: students should be able to: (i) Differentiate types of polygons (ii) Calculate sizes of interior angles of polygon.

Teaching Aid: Charts.

Procedure:

Step I: The teacher presents different types of polygon on charts and then define polygon as any plane figure with straight sides. Polygons are name after the number of sides they have.

Triangles	-	3 sides
Quadrilateral	-	4 sides
Pentagon	-	5 sides
Hexagon	-	6 sides
Heptagon	-	7 sides
Octagon	-	8 sides
Nonagon	-	9 sides
Decagon	-	10 sides

Also a regular polygon has all sides and angles to be equal.

Step II:Teacher ask students to draw a pentagon and use ideas of joining one vertex to all the other verticals to divide the pentagon into triangles. They will find that the number of triangles depend on the number of sides of the polygon. Thus, it will be deduced that for any polygon with n-sides, there will be n-2 triangles. Thus the sum of the angles of an n-sides polygon

$= (n - 2) \times 180^0$

Step III: The teacher use the above formular to calculate the size of an angle of a regular heptagon as example;

Solution:

$S = (n - 2) \times 180^0$ put $n = 7$

$S = (7-2) \times 180^0$

$= 5 \times 180^0 = 900^0$

Each angle = $\frac{900}{7} = 128.5^0$

Step IV: The teacher asks students to use the above idea to calculate how many sides has a polygon whose sum of angles is 1980^0?

Evaluation: Theteacherasks students to calculate as exercise, the size of each angle of a regular (i) Hexagon (ii) Decagon.

APPENDIX C: GEOMETRIC PERFORMANCE TEST (GPT)

Section A: Personal Data

Name of School _____

Class _____

Gender: Male [ ] Female [ ]

Section B: Achievement Test

APPENDIX II

Geometry Achievement Test for JSS II circle only the correct answer in this section.

1. How many sides have a parallelogram?

   (a) 3 (b) 4 (c) 5 (d) 6 (e) 8

2. How many angles have a parallelogram?

   (a) 4 (b) 5 (c) 6 (d) 7 (e) 8

3. The total sum of angles of any parallelogram is …

   (a) 90 (b) 60 (c) 180 (d) 360 (e) 270

4. At the centre where diagonal of a parallelogram cross, how many angles are acute?

   (a) None (b) 3 (c) 4 (d) 5 (e) 2

5. How many sides have a rhombus?

   (a) 8 (b) 7 (c) 5 (d) 4 (e) 3

6. At the centre where the diagonal of a rhombus cross, there are 4 angles, what kind of angles are they?

(a) Acute (b) Straight line (c) Right (d) Obtuse (e) Reflex

7. How many sides have a Kite?

   (a) 2 (b) 3 (c) 4 (d) 5 (e) 6

8. At the centre where the diagonals cross, there are 4 angles what kind of angles are they?

   (a) Acute (b) Obtuse (c) Reflex (d) Circular (e) Right

9. A quadrilateral is a plane shape with …

   (a) 3 sides (b) 4 sides (c) 5 sides (d) 6 sides (e) 7 sides

10. A parallelogram is a quadrilateral which has … sides equal

(a) 2 opposite (b) 3 opposite (c) 4 opposite (d) 5 opposite (e) 6 opposite

11. Decide which statement is true

(a) All parallelograms are trapezium (b) all squares are kite

(c) all trapezium are parallelogram (d) all squares are trapezium

(e) some kites are rhombus

12. Calculate the size of each of a regular hexagon

(a) 720 (b) 540 (c) 360 (d) 120 (e) 30

13. If the angles of a pentagon are x, 2x, 3x, 4x, and 5x. Calculate the value of 5x.

(a) 36 (b) 72 (c) 108 (d) 144 (e) 180

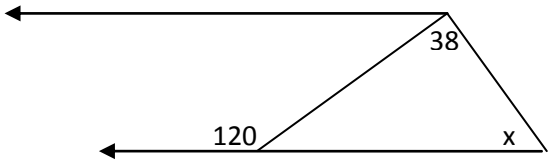
14. How many sides has a polygon if the sum of its angles is 2340?

(a) 13 (b) 15 (c) 11 (d) 9 (e) 8

15. Calculate the 4^{th} angles of the quadrilateral whose other 3 angles are 100, 60 and 80.

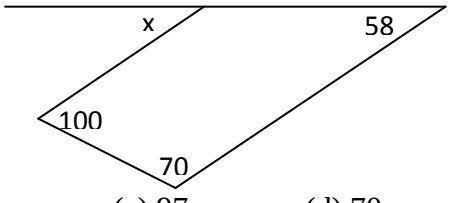
(a) 120 (b) 100 (c) 80 (d) 60 (e) 30

16. Calculate the size of the lettered angle in the following figure.



(a) 45 (b) 135 (c) 98 (d) 82 (e) 127

17. Find the value of the angle marked 2x in the figure below



(a) 48 (b) 96 (c) 97 (d) 70 (e) 35

18. If a polygon is regular with sum of its angles as 3960^0. What is the size of each angle?

(a) 198 (b) 165 (c) 155 (d) 135 (e) 100

19. A triangle is any plane shape having a

(a) 3sides (b) 4 sides (c) 5 sides (d) 6 sides (e) 2 sides

20. A right angled triangle is a triangle that one of its angles is …

(a) 60 (b) 30 (c) 90 (d) 180 (e) 360

21. The sum of angles of a triangle is …

(a) 360 (b) 90 (c) 150 (d) 180 (e) 270

22. The longest side in a right angled triangle is known as …

(a) Adjacent (b) Hypotenuse (c) Opposite (d) Diagonal (e) Transversal

23. Calculate the size of an angle of a regular 15 sided polygon …

(a) 15 (b) 150 (c) 152 (d) 154 (e) 156

24. Find the sum of the angles of hexagon

(a) 720 (b) 620 (c) 520 (d) 420 (e) 230

25. The sum of 3 of the angles of a nonagon is 462^0. The other 6 angles are all equal to each other. Calculate the size of one.

(a) 798 (b) 12600 (c) 462 (d) 624 (e) 133

26. The sum of 4 of the angles of a heptagon is 600^0. The other 3 angles are of the size 4x, 5x and 6x. Find the value of 6x.

27. A quadrilateral has angles of 128^0, 91^0, 9^0 and $2a^0$. Find the value of $2a^0$ …

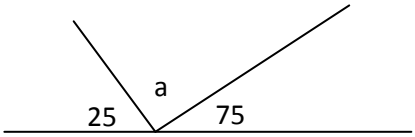
(a) 47 (b) 94 (c) 219 (d) 73 (e) 120

28. The sum of the angles of a polygon is 1620^0. Calculate the number of sides the polygon has. (a) 7 (b) 9 (c) 11 (d) 12 (e) 13

29. Find the size of the 4th angle of a quadrilateral with one right angle whose other 2 angles are; 127 and 87.

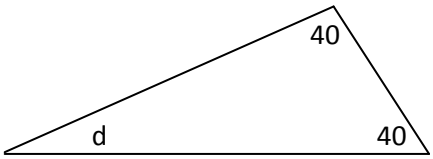
(a) 90 (b) 60 (c) 59 (d) 360 (e) 45

30. Find the size of the lettered angle in the following figure.



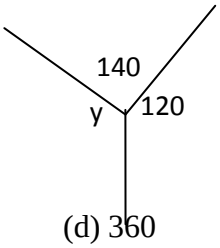
(a) 25 (b) 75 (c) 180 (d) 90 (e) 80^0

31. Calculate the value of d in following figure.



(a)180 (b) 40 (c) 100 (d) 70 (e) 50

32. Find the value of y in the figure below.



(a) 100 (b) 120 (c) 140 (d) 360 (e) 180

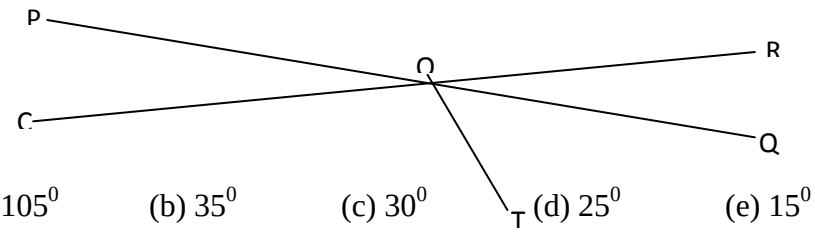
33. A regular polygon has … sides and ... angle equal

(a) 2 (b) 3 (c) 4 (d) 5 (e) all

34. Which of the following quadrilateral is regular polygon?

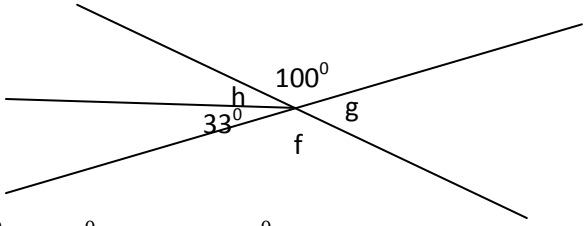
(a) Rhombus (b) Rectangle (c) Square (d) Trapezium (e) Kite

35. In the following figure POQ and SOR are straight line. If POS = 40 and TOQ = 65^0. Calculate TOR.



(a) 105^0 (b) 35^0 (c) 30^0 (d) 25^0 (e) 15^0

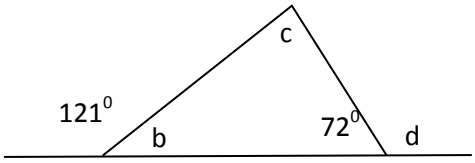
36. Find the sizes of the lettered angles.



(a) f = 100^0, g =80^0, h=47^0 (b) f = 90^0, g=75, h=47 (c) f = 110^0, g=47^0, h=80^0

(d) f = 120^0, g=80^0, h= 47^0 (e) f = 125^0, g=80^0, h=47^0.

37. Find the sizes of the lettered angles.



(a) b = 49^0, c =59^0, d=108^0 (b) 59^0, c = 49^0, d=108^0, (c) 108^0, c=69^0, d=49^0

(d) b = 50^0, c=40^0, d= 100^0 (e) b = 90^0, c=70^0, d=118^0.

38. The right angle of triangle is called …

(a) Opposite (b) Hypotenuse (c) Adjacent (d) Straight (e) Pentagon

39. The polygon with 10 sides is called ….

(a) Polygon (b) Hexagon (c) Decagon (d) Nonagon (e) Pentagon

40. An equilateral triangle has …

(a) All sides equal (b) One side equal (c) No side equal

(d) Two side equal (e) Four side equal

ANSWERS TO THE GEOMETRIC ACHIEVEMENT TEST

1.	b	11.	e	21	d	31.	c
2.	a	12.	a	22.	b	32.	a
3.	d	13.	e	23.	e	33.	e
4.	e	14.	b	24.	d	34.	c
5.	d	15.	a	25.	e	35.	d
6.	c	16.	d	26.	a	36.	a
7.	c	17.	a	27.	b	37.	b
8.	e	18.	b	28.	c	38.	b
9.	b	19.	a	29.	c	39.	c
10.	a	20.	c	30.	e	40.	a

APPENDIX E: STUDENT GEOMETRIC ATTITUDE QUESTIONNAIRE

JSS II

Dear Respondent,

I wish to request for your help in collecting necessary data on a research title "Effects of Guided-discovery and Problem-solving Strategies on JSS students' Performance and Attitude to Geometry in Zaria.

This research is an academic exercise, therefore, your honest response will help in improving the teaching and learning of Mathematics geometry in our Schools.

Thank you.

Maikudi Julie

Instruction: Please indicate to what extent you agree with the following statement by choosing the corresponding options as below:

Rating: SA = Strongly Agree

A = Agreed

D = Disagreed

SD = Strongly Disagree

S/N	Statement	SA	A	D	SD
1	I like geometry.				
2	Geometry lessons are fun.				
3	Learning is good.				
4	Geometry is not good for my life.				
5	I think we should all learn geometry.				
6	Time is wasted during geometry teaching.				
7	I would like to do more geometry.				
8	I think geometry is too hard to me.				
9	Geometry is just not important to me.				
10	A test in geometry makes me unhappy.				

11	I don’t understand questions in geometry.				
12	I learn things quickly in geometry.				
13	Hard work can increase one’s ability in geometry				
14	I hate diagrams in geometry.				
15	I think my teacher is not teaching geometry well				
16	My mind goes blank and I am unable to think clearly when working geometric problems.				
17	I put off turning in geometric homework for as long as I can.				
18	Geometry is worthwhile and a necessary branch of Mathematics.				
19	It is important for me to do well in geometry classes.				
20	I almost never have gotten shook up during a geometric test.				