EFFECTS OF JIGSAW II AND GUIDED DISCOVERY STRATEGIES ON RETENTION AND ACADEMIC PERFORMANCE IN GEOMETRY AMONG JUNIOR SECONDARY SCHOOL STUDENTS IN ZARIA METROPOLIS, NIGERIA

BY

Ladi STEPHEN
B.ED MATHEMATICS EDUCATION, A.B.U ZARIA (2007)
MED/EDUC/28385/2012- 2013 (P16EDSC8198)

DEPARTMENT OF SCIENCE EDUCATION,
FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
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Ladi STEPHEN
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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER DEGREE IN MATHEMATICS EDUCATION

DEPARTMENT OF SCIENCE EDUCATION,
FACULTY OF EDUCATION,
AHMADU BELLO UNIVERSITY,
ZARIA

OCTOBER, 2018

DECLARATION

I Ladi STEPHEN (M.Ed/Educ/28385/2012-2013; P16EDSC8198) declared that this dissertation entitled "Effects of Jigsaw II and Guided Discovery Strategies on Retention and Performance in Geometry among Junior Secondary School Students in Zaria Metropolis, Nigeria" has been conducted by me in the Department of Science Education, Ahmadu Bello University Zaria under the supervision of Prof. Y.K. Kajuru and Dr. M. O. Ibrahim.The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of the dissertation was presented for another degree or diploma at any University.

_____ _____

Ladi STEPHEN Date
Reg. No.: M.Ed/Educ/28385/2012-2013
(P16EDSC8198)

CERTIFICATION

This dissertation entitled “Effects of Jigsaw II and Guided Discovery Strategies on Retention and Performance in Geometry among Junior Secondary School Students in Zaria Metropolis, Nigeria" byLadi STEPHEN (M.Ed/Educ/28385/2012-2013; P16EDSC8198), met the regulations governing the award of Master’s Degree in Mathematics Education of Ahmadu Bello University, Zaria, and is approved for its contribution to the knowledge and literary presentation.

_____ _____

Prof. Y.K.Kajuru Date
Chairman, Supervisory Committee

_____ _____

Dr. M. O. Ibrahim Date
Member, Supervisory Committee

_____ _____

Prof. S. S. Bichi Date
Head, Department of Science Education

_____ _____

Prof. S. Z. Abubakar Date
Dean, School of Postgraduate Studies

DEDICATION

This dissertation is dedicated to my parents Mr. & Mrs. Stephen Bonire

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ABBREVIATIONS

EG	Expert Group
ES	Expert Sheet
GDMI	Guided Discovery Method of Instruction
GPT	Geometry Performance Test
GRT	Geometry Retention Test
GJSS	Government Junior Secondary School
HG	Home Group
J2MI	Jigsaw IIMethod of Instruction
MAN	Mathematics Association of Nigeria
NECO	National Examination Council
NMC	National Mathematical Centre
JSS	Junior Secondary School
WAEC	West African Examination Council

OPERATIONAL DEFINITIONS OF TERMS

Cooperative learning: this is a method of instruction that involves students working together in small groups to achieve a specific joint goal.

Discovery learning: this is an approach to instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments.

Jigsaw II: This is a cooperative learning strategy where students are assigned to a heterogeneous group (using some coding system) called the Home Group (HG) based on the number of items in the content to be learnt. All the members in the HGs with the same code are grouped again into different Expert Groups (EG) where they learn only a part of the entire material content called the Expert Sheet (ES). They return to their home group, teach all their group members and take quizzes all based on the original material. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process.

Lecture Method: this is a teaching method that involves primarily an oral presentation given by an instructor to a body of students.

Retention: this is the ability to retain and recall information or knowledge gained after learning.

Expert Group: A group in the Jigsaw method that is meant to learn and masteronly a portion of the entire material or topic within a stipulated time frame.

Expert Sheet: This is a list, figures, sub-topics or materials which is part of the entire material students in the expert group (EG) are expected to master and in turn teach the members of their home group (HG). Each EG has a different expert sheet (ES).

Home Group: This is the basic group which every learner must belong to before proceeding to an Expert Group to master an area from

the entire material and return again to teach other members ofthe group.

ABSTRACT

This study examined the Effects of Jigsaw II and Guided discovery strategies on retention and academic performance among junior secondary school students ingeometry, Zaria Metropolis, Nigeria.The study was guided by four research questions and four hypotheses. The quasi experimental research design involving three groups (two experimental and one control) were used. The population of the study comprised of Government JuniorSecondary School (GJSS) two (JSS2) students of the public schools in Zaria Educational Zone of Kaduna State. The sample of students for the study comprised of 194 students from three intact classes selected from three GJSS.Two instruments:Geometry Performance Test (GPT) and Geometry Retention Test (GRT) were used for data collection. The research hypotheses were tested using the t-test, Analysis of variance (ANOVA) and Scheffe's post hoc test at $P \leq 0.05$ level of significance by the aid of the computer software Statistical Packages for Social Sciences (SPSS version 23). The results obtained showed significant differences in performance of studentswith those exposed to the Jigsaw II Method of Instruction (J2MI) performing better followed by those taught using the Guided Discovery Method of Instruction (GDMI) while the lecture group was observed to have performed the least. The results also revealed no significant difference in performance of male and female students when exposed to the J2MI. In addition, no significant difference in performance was observed when male and female students were taught geometry usingGDMI. In terms of retention ability, the result revealed a significant difference among students with those exposed to J2MIretaining best, followed by the (GDMI) group. The lecture group was observed to have the least retention level.The study concludes that J2MI and GDMI are effective teaching methods that can be explored as alternatives to the lecture method in the teaching of geometry among JSS students. Moreover, J2MI and GDMI are both gender friendly teaching method. Based on the findings, it is recommended that Teachers should employ the use of J2MI and GDMI as alternative to lecture method in the teaching of geometry at JSS level to enhance students' performance and retention ability. The strategies also facilitate the learning of much material in limited time which can help the teacher and students cover large portions of the school syllabus. Both methods are also gender friendly hence; they can be used in both single and mixed schools. Workshops and seminars for mathematics and science based teacher should be organized by the Ministry of Education for Kaduna State on the use of the J2MI and GDMI.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Teaching is a process of using appropriate method, staff and material in order to reach in the most effective manner to the predetermined goals (Tuna & kacar, 2013). Instructional method can be described as the way of achieving learning outcomes. Learning can be enjoyable if teachers use appealing instructional methods. There are so many devices for effective teaching and an effective technique can be ensuring effective learning (Parveen, 2010).

Mathematics education which includes the practice of teaching and learning mathematics has consistently generated interest among scholars over the years. This is because of its importance which affects every facet of human activity such as: politics, economy, science and technology (Kadala, 2014). It is the importance of mathematics that compelled the Federal Government of Nigeria to make mathematics a compulsory subject at the primary and secondary levels of education and consequently a necessary requirement for admission into the Nigerian universities (Aburume, 2008; Matthew & Kenneth, 2013).

Despite these measures,student's performance in this subject has remained very low for many years and one area where students were found to perform poorly is geometry. Yakubu (2014), observed that teacher's attitude towards geometry and their understanding of the area was not encouraging. This position was also held by Sani (2015) who asserted that teachers exhibit poor attitude and understanding towards geometry.

These have far reaching effects on the nation's goal of attaining Science Technology and Mathematics Education (STME) by the year 2020 (Kadala, 2014). Nwabugwu (2012)

reported that the Federal Government described the poor performance of students in Nigeria as unacceptable and warns that the trend has to be checked if the country has to move forward. Popoola (2013),Ndakotsu (2014), Ahmadu (2014) and Timayi&Otalu (2015), observed that the reasons for failure in mathematics is in the areas of poor students' performance, unqualified teachers, poor method of teaching and negative attitudes of students towards learning the subject. Hence Takahashi (2007), Popoola (2002) in Akinsola & Animasahun (2007) observed that an instructional method is crucial to the understanding of mathematical concept. Effective instruction requires the teacher to step outside the realm of personal experience unto the world of the learners (Timayi& Otalu, 2015).For the purpose of the study, three (3) instructional methods were compared these are the lecture method (LM), discovery method (GM) and the Jigsaw II method of instruction (J2MI).

The lecture method which is also called the traditional method allows a teacher to deliver a large amount of information in a short period of time preparation is done by an individual and can be repeated on a routine basis for each new group of learners. It is used to introduce students to a new subject and valuable method of summarizing ideas, showing relationship between theory and practice and re-emphasizing the main point. The instructor is required to read necessary illustration or demonstration may be given as a complement to the information in the lecture note. It involves verbal presentation of facts ideas and concepts (Popoola, 2013). However, the lecture method does not stimulate student's innovation intuition and scientific attitudes and cause learners to become bored and easily distracted (Ndakotsu, 2014). This is because the teacher dominates classroom talk and students talk only when called upon to answer questions or when they are permitted to ask questions (Tanner, 2009; Odundu &Gunga, 2013). It is teacher centered Adeyemi (2008) notes that

lecture method encourages students to cram facts which are easily forgotten. Mc Dowel (2001) notes that instructional methods that encourage memorization and reproduction are short of knowledge that can be used to solve problems in new situations (Tella, Indoshi&Othuon, 2010).

Discovery method is ateaching approach where students find out a piece of knowledge, information or truth by themselves through observation, demonstrating etc. here teachers use two distinct approaches namely inductive (Guided discovery) and deductive approach.In deductive approach, we ask deductive reasoning when applying a general role to a particular case, i.e. from generalization to particular. Students make use of knowledge that they have acquired previously to acquire a new knowledge.Induction means to offer a general truth by showing, that if it is true for a particular case. It is true for all such cases. It is psychological in nature and a method that develops curiosity within the individual which is need of the day.

Inductive approach is based on the process of induction in teaching learning process. In the world of mathematics it is a method of constructing a formula with the help of a sufficient number of concrete, actual and real examples. By using this method of teaching mathematics the students follow the content with great interest and understanding at various levels especially at elementary level. Inductive method is more useful in algebra, geometry, trigonometry and arithmetic teaching and learning. Inductive method proceeds from particular examples to general rules of formulae, concrete illustration to abstract rules, known to unknown and simple to complex (Atta, Ayaz & Nawaz, 2015).

Guided discovery method according to Matthew et al (2013) is a teaching method that enables students to move step-by-step from the identification of a problem, defining the problem, formulation of hypothesis, collection of data, verification of results and generation

to the drawing of conclusion. Guided discovery method of instruction (GDMI) is an aspect of transformational teaching which has been spurred by the development of several learning principles and methods of instruction, including, active learning, student-centered learning, and problem based learning (Rosebrough & Leverett, 2011). It is a student-centered method whereby students interact actively, question assumption and provide their view points on any area of subject matter (Peters, 2000; Matthew & Kenneth 2003; Olibie & Ezeoba (2013). As described by Olibie and Ezeoba (2013) in this approach to instruction, the teacher facilitates and prompts students to conduct investigations and construct their own meaning and phenomenon that occur naturally. It is through such levels of ability that learning takes place (Riasat, Hukamdad, Aqila & Anwar, 2010). GDMI also emphasizes higher-level thinking skills and collecting analyzing and synthesizing information and data from multiple source and viewpoints (Cummins, 2007; Wilson, Taylor & Kowalski, 2010). Otiende, Barchok and Abura (2013) observed that failure in discovery learning is seen as a positive circumstance. Thomas Edison tried 1,200 designs for lights bulbs before finding one that works. He never got discourage because he felt that he had learned thousands of designs that do not work. Therefore, learning also occurs through failure. Psychologists showed that failure is central to learning. They argued that if a student does not fail while learning, the students probably has not learnt something new GDMI also exposes students to circumstances of failure hence learning through mistakes.

This underscore the need for discovery method however GDMI wastes time, cannot be used for every mathematics concept and it can be boring to slow learners. It requires a lot of materials to be used and its time consuming because it demand that the teacher prepare his lesson very well (Stephen, 2007).Co-operative learning is a teaching strategy in which small

teams, teach with students of different levels of ability using a verity of learning activities to improve their understanding of a subject (Suleiman, 2014; Yaji, 2014).

In this instructional method, students take a participative role by leading discussions and teachers become facilitators. In this regard, teachers facilitate student's discussion and interject only when necessary allowing students to put the language to use and explore aesthetics of learning materials (Eken, 2000; Ahmad & Aziz, 2009; Odundu & Gunga 2013).

Jigsaw, a model of cooperative learning was originally developed by Eliot Aronson (1978). It emphasizes conceptual learning and development of social skills as learners work together in small heterogeneous group according to the principle of positive interdependence, individual accountability, face to face promotive interaction and group processing (Olarewaju, Awofala, Fatade&Olaoluwa, 2012).However, co-operative learning is associated with a number of shorting comings such as consuming time and sometimes it's difficult for the teacher to plan the lesson, if the group are ability wise, the less fortunate ones may be discouraged, it is too demanding on the part of the teacher and hinders teachers from knowing individual's views and problems (Stephen, 2007).

Process that take place during the application of jigsaw are as follows; from groups of 4 or 5 students, there may be 3-7 groups depending on the number of students. The learning materials are distributed to the groups, each group has different learning task and will learn their task very well to the extent that each member of the group master the topic given to them in the class, each group will come out and teach the whole class what they had learnt (Suleiman, 2014).

Poopola (2010) defined academic performance as an expression used to present students scholastic standing and which is a function of various factors such as method of teaching,

teacher qualification, child's home background, school background, school environment, attitude and interest among others. Therefore, for the purpose of the study academic performance refers to the marks obtained in a test prepared by the researcher on selected topic. (Matthew& Kenneth, 2013).

Manko (2015) define mathematics retention as having the ability of reproducing mathematics concept or part of it after some period of time. For the purpose of this study, retention is defined as the ability to recall the knowledge of geometry leant when required

Gender refer to the social meaning associated with being a male or a female, including the construction of identities, expectation, behaviours and power relationships that derive from social interaction (Ambeuva, Iwuckukwu and Jibril 2008)

1.2 Statement of the Problem

The poor performance of secondary school students in mathematics has been a concern to both government and parents (Ahmadu, 2014). In an attempt to improve students' performance some parents arrange and pay for extra-tuition for their children, so that may understand mathematical concept better and cover all topics within the syllabus. These concepts taught at the secondary school level in Nigeria was categorized into seven major areas namely; number and numeration, Algebra, Mensuration, Geometry, Trigonometry, Statistics and probability. Geometry the world over has been a hated branch of mathematics to many students (Inekwe, 2002). Ahmadu (2014) is of the same view and further submitted that the concept is difficult to many students and difficult for teachers to teach.

Statistics published by West African Examination council and senior secondary school certificate examination revealed that for the past seven years (2008-2014) less than 40% of Nigerian students obtained credit passes each of the years in their senior secondary school

examination. Also, the nation was alarmed by the results released by (NECO) national examination council in 2010 which indicates that over 92.8% of students who took the secondary school certificate examination could not obtain a minimum qualification for entry into the tertiary institution one major cause for this unfortunate situation was the poor performance in General mathematics and geometry in particular over the years. WAEC chief examiners report (2008-2012) clearly lamented on the poor performance of the candidates in geometrical aspect of the questions, worse still only few candidates attempted questions on geometry, chief examiner report that students' performance in mathematics examination especially geometry, both internal and external has not been encouraging (WAEC, 2005), which is also applicable to the Junior secondary certificate examination (JSCE). Chief examiners report on the students' areas of deficiency in JSCE shows that students least understood geometry as shown by their performances, they avoid geometry questions or haphazardly attempted them (JSCE 2011-2012).Thus, for many years now the different teaching methodologies employed in teaching mathematics (Geometry) in secondary schools have not improved students'performance in the subject to an appreciable level. Moreover, research in many areas of education has shown that the methods of teaching utilized by the teacher is an important factor in students' learning and subsequent performance in examinations (Obeka, 2014; Manko, 2015). Hence there is the need to try out other method to salvage the situation. The instructional approach employed by teachers in the teaching of geometry is ineffective and hence students perform poorly due to inadequate knowledge acquired from these methods. Based on these problems, this study investigated the effects of two instructional methods (guided discovery and Jigsaw II method of instruction) on

students' academic performance in geometry among junior secondary schools in Zaria educational zone.

1.3 Objectives of the Research

The main objective of this study is to investigate the effects of guided discovery and Jigsaw II method of instruction on students' academic performance in geometry among junior secondary schools. Specifically, the objectives of the research are as to:

1. determine the performance of students taught geometry using Jigsaw IIMethod of instruction (J2MI) and Guided Discovery Method of instruction (GDMI).
2. investigate the performance of male and female students taught geometry using Jigsaw II Method of instruction (J2MI).
3. determine the performance of male and female students taught geometry using Guided Discovery Method of instruction (GDMI).
4. investigate the retention level of students taught geometry using the JigsawII Methodof instruction (J2MI) and the Guided Discovery Method of instruction (GDMI).

1.4 Research Questions

The following questions were asked as guide to the study:

1. What is difference among the performance of students taught geometry using J2MI, GDMI and those taught using the lecture method (LM)?
2. What is difference between the performance of male and female students taught geometry using J2MI?

3. Is there any difference between the performance of male and female students taught geometry using GDMI?
4. What is difference among the retention level of students taught geometry using J2MI, GDMI and those taught using the lecture method (LM)?

1.5 Null Hypotheses

Based on the research questions, the following null hypotheses were tested at $P \leq 0.05$ level of significance:

Ho_1: There is no significantamong the performance of students taught geometry using J2MI, GDMI and those taught using the LM?

Ho_2: There is no significance between the performance of male and female students taught geometry J2MI.

Ho_3: There is no significance between the performance of male and female students taught geometry using GDMI.

Ho_4: There is no significance among the retention level of students taught geometry using J2MI, GDMI and those taught using LM.

1.6 Significance of the Study

This study will hopefully be beneficial to students, teachers, the government and other researchers in the following ways:Students will be motivated to develop interest in mathematics (Geometry) learn and understand it. Also, the use of effective method will remedy poor performance and poor attitude of students toward the subject. Learning will be permanent in students because they discover things themselves. Relationship among learners can be enhanced; which brings about self-esteem and this in turn will improve academic

performance in the subject. This will build a stronger foundation to mathematical skills for lifelong learning.

Teachers can adapt and employ GIM and J2MI as a guide and method for the teaching of geometry in our junior secondary schools. It enlightens and encourages teachers to see monitoring of students' progress to the learners as an opportunity to get close to the learners, identify their learning challenges and co-operate improve learning, quality teaching, effectiveness and accountability to students. Hopefully, the findings of the study with regard to retention will foster good retentive memory among students of concepts learnt and in turn facilitate better performance in mathematics in general.

The finding of the study and subsequent recommendation can bring about mathematical revolution that Nigeria seeks in vision 20:20 agenda sought by other countries to be among the industrialized nation of the world. To make the method popular, curriculum planners and text book writers can also include these children centered methods as effective for teaching and learning of geometrical concepts. Other researchers can use this study in their own thereby exploring and discovering newer grounds.

In totality, the findings of this study is expected to bring about reduction in poor performance in mathematics among junior secondary schools, and enhance mathematical skills in them. It is also hoped that science and research based organization like Teachers Association of Nigeria (MAN), National Education Research and Department Council (NERDC), National Mathematical Centre (NMC) and others will find this study useful.

1.7 Basic Assumptions

The following assumptions were made for this study:

1. All JSS teachers have a copy of the National Mathematics Curriculum.

2. JSS two students have covered the JSS one mathematics syllabus.

1.8 Scope of theStudy

This research was delimited to investigating the effects of instructional methods on students' academic performance in geometry among junior secondary school students, Kaduna State. The study is restricted to Junior Secondary two (JSII) students of the public schools in Zaria Educational Zone of Kaduna State. The following topics in geometry namely: definition and properties of parallelogram, rhombuses and kites, connections and relationship between quadrilaterals and the environment. Others are angles between lines and angle in a triangle and angles in a quadrilaterals and angle in a polygon.

Two instruments were used for the study namely the Geometry Performance Test (GPT) and Geometry Retention Test (GRT). GPT and GRT are both a forty (40) multiple-choice items developed by the researcher from past question papers of JSCE and the New General Mathematics (NGM) for JSS2 covering questions and units of geometry.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter will review literatures relevant for the study effects of instructional methods on students' academic performance in geometry among junior secondary school students, Kaduna State. The aim of the study is to determine the performance of students taught the geometry using the Jigsaw method of instruction (J2MI) and the guided discovery method of instruction (GDMI). The study will also investigate the performance of male and female students taught the geometry by the Jigsaw method of instruction (J2MI) and the guided discovery method of instruction (GDMI). The discussions will be done under the following sub-headings:

2.1 Introduction

2.2 Theoretical Framework

2.3 Nature and Teaching of Geometry at Junior Secondary School Level

2.4 Geometry and Academic Performance of Junior Secondary School Student

2.5 Gender Performance in Geometry

2.6 Method of Teaching Geometry in Junior Secondary Schools

2.7 Lecture Method of Instruction

2.8 Discovery Method of Instruction

2.9 Cooperative Method of Instruction

2.10 Retention in Junior Secondary School Geometry

2.11 Overview of Related Studies

2.12 Implication of the Literature Review on Present Study

2.2 Theoretical Framework

The theoretical framework adopted for this study was based on three theories of learning: the constructivist theory, Ausbel's theory of meaningful learning and problem – solving strategy theorem. There are two basic traditions of constructivism.The first psychological constructivism originating from Jean Piaget's account of children's learning as a process of personal individual, intellectual construction arising from their activity in the world.The second is epistemology which emphasizes these two principles which make up radical constructivism; often serves as a reference position for discussions of constructivism in education (Garrison, 1986). The first principle state that knowledge is not received passively but it is words it is not possible to transfer ideas into students' heads, rather students construct their own meanings from the words or visual images they hear or see. Consequently, when engaging this construction of meaning, what the learner already know is of central importance.

The second principle states that the function of cognitive is adaptive and enables the learner to construct viable explanations of experiences. Consequently, knowledge about the "word outside" is viewed as a human construction. A 'reality' outside is not denied, but it is possible to know about the reality only in a personal and objective way (Duit, 1993). Rather than being concerned with knowledge as the representation of the truth, constructivism focuses on the way in which learners construct viable and useful knowledge. According to this position, the only constructions that survive are those that prove to be successful in dealing with multiple contexts in which the learner is engaged. A third aspect highlights the fact that although individuals has to construct their own meaning of new phenomenon or idea, the process of constructing always embedded within the social setting of which the individual is a part.

Constructivism is a theory which accepts the child ownership of ideas (Nworgu, 1997). Central to the constructivist perspectives is that a learner constructs meaning from new information and event as a result of an interaction between that individual's alternative concepts and his or her current observation. The implication of constructivism according to Kato and Kamoi (2001) is that the child becomes very autonomous refusing to be governed by reward and punishment thus constructivists believe that students should not learn by receiving message but by interpreting a message. This implies that students must take responsibility for their learning. This is because they have to be actively involved in the teaching and learning process. They have to put their own ideas and search for understanding. This is the central focus of Jigsaw method of instruction and guide discovery method of instruction.

This study is also based on Ausubel's theory of meaningful learning (Ausubel, 1968). This theory posits that new knowledge can be learned most effectively by relating it to previously existing knowledge. Jigsaw learning strategy may be viewed as a methodology tool of meaningful learning theory that displays fundamental elements of the theory such as sub-symptom, integrative reconciliation and progressive differentiation. Jigsaw strategy will allow or permit a learner to carryout activities that will aid his learning and also teach others. The basis of the study is to involve students in search of knowledge using J2MI and GDMI so that meaningful learning will take place which in turn serves as an anchorage for new material to be learned.

Also problem solving strategy theorem developed by Polya (1971)involve teaching using the four –step processes, viz

1. Understanding the problem

2. Device a plan
3. Carry out the plan, and
4. Look back

2.3 The Nature and Teaching of Geometry at Junior Secondary Schools

Geometry is a branch of mathematics that studies space and special relationship. It is a way of reasoning that can be used to understand and analyses imagined spatial and physical environment. Choi (2013) observed that geometry offers ways to interpret and reflect on the physical environment which enables students to link geometry to their daily lives. Yakubu (2014) submitted that the study of geometry contributes immensely in assisting student to develop skills of critical and logical thinking, problem solving and deductive reasoning. Therefore, geometry is a source of mathematics thinking. It kindles man's interest to observe shapes around him and make conjectures about their relationship which further stimulate curiosity and encourages exploration.

Geometry is an interesting area of mathematics, full of surprising theorem and wonderful problems. Hassan (2010) posited that his ability to apply geometric concept and theorems is a life skill needed in many occupations, infact, learning of geometry greatly enhances learning of other areas in mathematics. This is because geometrical illustrations are usually used to visualize other mathematical concept clearly.

Studies on the biological explanation of gaps in performance between male and female learners suggest tha difference in brain structure, hormone production and/or maturation rates may account for differentiated performance in school-related task. Studies further shows that the parts of the brain responsible for processing verbal information and permitting the exchange of information between hemisphere were more highly developed in girls (Kimura,

2005). Girls also demonstrated earlier development in the brain region responsible for impulse control, an in general matured earlier than boys(Viadero, 2006). However, the extent to which these biological differences manifested themselves in behavioral difference and their implication for learning was unknown (Olasehide & Olatoye, 2014).

Many reasons have been advanced for low performance of female students in mathematics, some studies reported that female are deficit in abstract reasoning. However, this argument has been proved wrong.

Difficulties encountered by teachers and students in the teaching and learning of Geometry. There are many challenges in teaching and learning of geometry. Researcher has documented that many learner encounter difficulties and show poor performance in geometry (Atebe, 2008; Alex & Mammen, 2011). Atebe andShafer (2009) stated that the teaching and learning of geometry is one of the most disappointing experiences in many schools across nations. Halat (2006) point out that National council of Teachers of Mathematics (NCTM, 2000) recommended that new educational theories and approaches should be used in teaching geometry to help students overcome their difficulties. However, Bal (2014) argues that attitude is an important predictor in the context of success in geometry.Overpopulation and lack of teaching aids makes it difficult for a teacher to teach geometry and difficult for students to understand due to lack of motivation and interest

2.4 Student's Performance in Junior Secondary School Geometry

Bossaert and Doumen (2011) defined academic achievement as the outcome of education i.e. the extent to which student, teacher or institution has achieved their educational goals. Academic achievements are usually commonly measure by examination. Students' academic achievement refers to student's performance or attainment in a subject. It also

meanscognitive scores (Ugwuadu, 2010). According to Nwagho (2001), achievement in teaching and learning process has to do with attainment of a set of objective of instruction. If a learner accomplishes a task (for example a geometrical problem) successfully and attains the specified goals for a particular leaning experience he is said to have achieved.

2.5 Method of Teaching Geometry in Junior Secondary schools

Some methods used in the teaching of geometry in secondary school include the following:

2.5.1 Lecture Method of Instruction

The word lecture comes from the Latin word Lectus, from the 14TH century which translates roughly into "to read". The term lecture, then in Latin means "that which is read" (Paris, 2014).Manko (2015) describe lecture method as a teacher centered and didactic with learner's simply listening, copying notes, doing class work and assignment. It emphasizes 'Talk and chalk' in the teaching of mathematics and is indeed oral presentation.

Paris (2014) defines lecture method as a teaching method that involves primarily an oral presentation given by an instructor to a body of students. Many lectures are accompanied by some sort of visual aid such as slideshow, a word document, an image or a film. Some teachers may even use a whiteboard or a chalkboard to emphasize important points in their lecture. As long as there is an authoritative figure (in any given context) at the front of a room, delivering a speech to a crowd of listener's.

A lecture is an oral presentation intended to present information or teach people about a particular subject, for example by a university or college teacher.Lecture method of teaching is a teacher centered method that does not offer activities leading students to think and make research (Suleiman, 2014). It is a teaching method where the instructor acts as the primary information giver. It is primarily used to introduce new subject, but it is also valuable for

summarizing ideas, showing relationships between theories and practice and re-emphasizing the main points (Abdullahi, 2012). Farooq (2012) describe lecture method as the oldest teaching method applied in educational institute. It is a one-way channel of communicating information. Students' involvement in this method is just to listen and sometimes pen down some notes if necessary during the lecture, combine t e information and organize it.

Kaur (2011) suggests that lecture is a method of teaching by which the instructor gives an oral presentation of facts or principles to learners and the class usually being responsible for note taking and this implies little or no class participation. Therefore, the aforementioned definition shows that lecture occurs whenever a teacher is taking and students are listening.

2.5.1.1 Types of Lectures

Lowman in Kaur (2011) has classified the major types of lectures as follows:

1. **Formal oral Essay:** This model can be considered as a highly-published kind of lecture that presents information primarily to support a conclusion. In this process the lecturer has reviewed and selected from a large body of knowledge the theories, research studies, and arguments that support his conclusion. The most formal of such lectures are written out and read to the students. Listening to one can be an emotionally and intellectually significant experience, but this kind of lecture is rarely used in the teaching process.
2. **Expository Lecture:** In this lecture the instructor does most of the talking, with only occasional questions from the students. These lectures are less elaborately planned than oral essay.

3. **Provocative Lecture:** There is more intention of provoking thought in this process. Hence the teacher challenges students' existing knowledge and values and help them to form a more complex and integrated perspective.
4. **Lecture Discussion:** Hence the teacher encourages students to comment or express concern rather than simply raise questions. The lecture discussion class begins with the instructor speaking for a few minutes and then stimulating a few minutes of discussion around a key point in his remarks. During such discussion the instructor offers brief clarification or integration between students' comments but students do most of the talking.
5. **Lecture Recitation:** In this process the teacher stops to ask specific questions or requests students share what they know or have prepared.
6. **Lecture Laboratory:** in this method students follow short lectures by making their own observations, experiments or other independent work. This lecture is used in science as well as in studio arts and writing classes.
7. **Lecture Discussion Cycle:** As it was described the lecture discussion method encourages students to think about the content being presented as well as heightening their involvement in the lecture proceedings. Therefore, it can be considered as a more valuable method than others.

2.5.1.2 Advantages of Lecture Method of Teaching

Charl (2006) Kaur (2011) and Farooq (2012) give the following advantages and disadvantages of lecture methods.

1. Many facts can be presented in a short time in an impressive way.

2. It is convenient way to instruct large groups, if necessary a public-address system can be used to amplify the speaker's voice.
3. The proper perspective and orientation of a subject can be presented and general outline of scope of the subject can be brought out.
4. It can stimulate very good interest in the subject.
5. Greater attention could be secured and maintained as interest leads to attention.
6. Spoken word has greater weight than mute appeal by books.
7. Lecture language can be made suitable to all members of the audience.
8. It helps students to develop their listening skills and instructors their communication skills.
9. It is flexible and easier for instructors due to simply "telling" students about the subject.
10. It can be used to present information that would be difficult for students to get in other ways, particularly if the students do not have the time required for research, or if they do not have access to reference material.

2.5.1.3 Disadvantages of Lecture Method of Instruction

Although the lecture method can help the instructor meet special challenges, it does have several draw backs Viz:

1. There is no co-operation and interaction between the teacher and pupils in the lecture process.
2. The problem –solving attitude of students may disappear in the lecture method.
3. In this process of lecturing, the learners are more passive than being active in the class.

4. A lecture delivered in a style not easily understood by students will serve no purpose.
5. If the lecture is very fast, the students cannot easily take notes and will not have any written record of the salient points made out.
6. The teacher to make the lecture more impressive may care more for the manner and style and not for or little for the content.
7. It is a waste of time to repeat the mater already present in books.
8. Attention level of subjects is not the same while listening to the lectures. An instructor finds it difficult to hold the attention of all the students throughout the class period.
9. Lectures are often forgotten by students soon after.
10. As a teaching method, the lecture does not bring about maximum attainment of certain types of learning outcomes. Motor skills, for example can seldom be learned by listening to a lecture.
11. It does not easily allow the instructor to estimate the students understanding as the material is covered. It provides no accurate means of checking students' progress.

2.5.2 Discovery Method of Instruction

Discovery learning is a technique of inquiry-based instruction and is considered constructivist based approach to education. It is supported by the work of learning theorists and psychologists such as Jean Piaget, Jerome Bruner, and Seymour Papert. Although this form of instruction has great popularity, there is some debate in the literature concerning its efficiency (Mayer, 2004).

Jerome Bruner is often credited with originating discovery learning in the 1960's but his ideas are very similar to those of earlier writers (e.g. John Dewey). Bruner argues that

"practice in discovering for oneself teaches one to acquire information in a way that makes that information more readily viable in problem solving". (Bruner 1961) this discovery later became the discovery learning movement of the 1960's. The mantra of this philosophical movement suggests that we should "learn by doing". In 1991, the Grauer school, a private secondary school in Encinitas, California, was found with the motto, "Learn by discovery", and integrated a series of worldwide expeditions into their programs for high school graduation.

Discovery method of Instruction "is a largely unstructured, situational method or philosophy of teaching whereby students are permitted to find solutions to problems on their own or at their own pace, often jointly in group activities, either independent or under the guidance of a teacher". Discovery learning is a method of inquiry-based Instruction. It believes that it is best for learners to discover facts and relationships for themselves by drawing their own past experience and existing knowledge. (Brunner 1967 in learning theories.com, 2015). Discovery learning refers to various Instructional design models that engages students in learning through discovery. Usually the pedagogical aims are threefold:

1. Promote "deep" learning
2. Promote meta-cognitive skills (develop problem-solving skills, creativity etc)
3. Promote students' engagement.

According to Edutechwiki(2015). "Discovery learning is a type of learning where learners construct their own knowledge by experimenting with domain, and interfering rules from results of those experiments..."Discovery learning, "is an approach to Instruction through which students interact with their environment by exploring and manipulating objects,

wrestling with questions and controversies, or performing experiments." (ormrod; 1995 in edutechwiki 2015).

Learning theorists characterize learning to solve problems as discovery learning, in which participants learn to recognize problems characterize what a solution would look like, search for relevant information develop a solution strategy and execute the chosen strategy." (Borthick and Jones, 2000). Discovery learning is a kind of teaching that is based on the student finding things out for themselves, looking into problems, and asking questions.

2.5.2.1 Definition of Guided Discovery Method

Guided discovery was developed by Dr. Charles E. Wales at the center for Guided Design, West Virginia University (Leutner, 1993). Guided discovery is a method of instruction where an instructor device a series of statement or questions that guide the learner, step by logical step, making a series of discoveries that leads to a single predetermined goal. In other words the instructor invites a stimulus and the learner reacts by engaging in active inquiry thereby discovering the appropriate response. (Mosston, 1972 edutechwiki, 2012).

Robert(2012) define guided discovery learning as a learner centered approach that combines didactic instruction with more students centered and task approaches. Here, the student solves problems but the teacher gives some coaching and/or feedback, and expository method in which the student is provided with correct answer along with the problem.Guided discovery is an approach where a teacher guides the students towards discovery by providing appropriate materials, a conducive environment and allotting time for students to discover. (Labush, 2015).

Guided discovery is a teaching approach that promotes teaching for understanding rather than memorization and focuses on explicit guidance, real world situations, hands-on

activities and scaffolding.According to Marzano (2011) in Wikipedia(2015) enhanced discovery learning(guided discovery learning) was described as a learning process that involves preparing a learner for the discovery learning task by providing a learner for the discovery learning task by providing the necessary knowledge needed to successfully complete a said task. In this approach, the teacher not only provides the necessary knowledge required to complete the task, but also provide assistance during the task.

2.5.2.2 Advantages of Discovery Method

The advantages of the Discovery Method of learning are as follows:

1. It encourages active engagement of the learner.
2. It promotes motivation, pleasure of successfully solving problems.
3. Promotes autonomy, responsibility and independence.
4. Students develop creativity and problem solving skills.
5. A tailored learning experience.
6. It results in "episodic memory" a deeper type of memory that allows students to connect information to events which creates stimuli for remembering the information.
7. Students can become dependent on guidance and direction to find answers.
8. While participating, students pay attention.

2.5.2.3 Disadvantages of Discovery

The of the discovery method are as follows:

1. Teachers may fail to detect problems and misconceptions.
2. It has the potentials to confuse learners if no initial framework is available.
3. It is inefficient, it is too time consuming for all academic activities.
4. It requires that a teacher prepare for too many corrections, a lot of things one discovers for themselves turns out to be wrong.

5. Learners maybe tired and discouraged if the objective is too hard, then there is the risk of learners not taking part fully.

2.6 Jigsaw Learning Strategy

The Jigsaw cooperative learning technique was developed by Elliot Aronson and his colleagues in 1978. It was created with the goals of reducing conflict, enhancing positive educational outcomes and to help students realize they are essential components of a whole and encourages cooperation in a learning environment. In order to create a more cooperative environment, Aronson and the teachers divided students into small groups that were diversified based on ability, ethnicity, and gender. This structure required students to take responsibility for their personal assignment in class and to work out any personal issues they had with one another. After eight weeks of using the jigsaw strategy, Aronson reported that students expressed less prejudice and negative stereotyping, displayed more self-confidence, and showed more positive attitudes to school than did their peers in traditional classes. Academically, students who participated in the jigsaw learning technique showed greater academic improvement than their peers.

In science education, the Jigsaw method and its variants are reported to be used in classes more often than other collaborative learning methods, especially in biology, chemistry, physics, Mathematics and the Earth sciences. There are currently six types of Jigsaw cooperative learning strategies available for teachers to use in the classroom (Jansoon, Somsook & Coll, 2008). They are: Jigsaw I, Jigsaw II, Jigsaw III, Jigsaw IV, Reversed Jigsaw and the Subject Jigsaw. These are discussed as follows:

i. **Jigsaw:** This can also be referred to as the Jigsaw I. It is the original work of Aronson and associates (Aronson, 2008). Students are members of two groups: home group and

expert group. The students work in a 'home group' which is heterogeneous in nature. They each are assigned to read an expert sheet, and then those who have the same expert sheet move from the home group to a separate expert group in which they then discuss their topic in detail. Once the discussion in the new group is complete, they return to their home group, and teach all their home group members about the topic that they are now expert in. Once back in their home group, each student is accountable for teaching his or her assigned topic (Jansoon *et al*, 2008; Maden, 2011). Finally, the groups are assessed, and individual grades are given.

ii. Jigsaw II:This is a modification of the Jigsaw I, it was developed by Robert Slavin's in 1987. In Jigsaw II, members of the home group are assigned the same material, but focus on separate portions of the material. Each member must become an "expert" on his or her assigned portion and teach the other members of the home group (Maden, 2011). This revised version of the method involves using computed team scores such as the Student Teams-Achievement Division (STAD) method. Also, Jigsaw II has two substantial changes: all students in the team read all the lessons, and the scores of students are combined to contribute to an overall team score. This method has been used for subjects in the social sciences, and in science particularly when the learning goals focus on concepts rather than skills.

iii. Jigsaw III: Jigsaw III was created by Stahl (1994). However, Gonzalez and Guerrero (1983) modified Jigsaw II to increase the interaction between students. It has an addition of a cooperative test review process. This cooperative test review involves reconvening the home group and reviewing the process.

iv. Jigsaw IV: The Jigsaw IV was developed by Holliday (2002). It is an improvement over the Jigsaw III; it includes three important new features: an introduction, quizzes, and re-teaching after individual assessment. In order to stimulate student interest in the lesson, the teacher first introduces the lesson by means of lectures, presentation of literature, questioning, proposing problems, or perhaps showing a movie in a ‘plenary’ class session. Students are then assigned to a heterogeneous group – the home group – and all students are assigned topics to read. Here each student discusses the expert sheet that is based on a list of all topics. Again, the students with the same expert sheet move to their expert group to discuss their topic. In order to check accuracy and understanding of students in the

expert group, they are assessed by means of a quiz – this being based on the expert sheet. They return to their home group, teach all their group members and take quizzes all based on the original material. The teacher reviews and clarifies any concepts which it appears the students did not understand. The students take individual quizzes, and scores are combined to produce an overall team score. Finally, the teacher re-teaches any material which was misunderstood after the individual assessment process (Jansoon *et al*, 2008). These features make the Jigsaw IV better than the others (Jigsaw I, II and III).

v. Reverse Jigsaw: The Reversed Jigsaw was created by Timothy Hedeen (2003). It differs from the original Jigsaw during the teaching portion of the activity. In the Reverse Jigsaw technique, students in the expert groups teach the whole class rather than return to their home groups to teach the content (Hedeen, 2003).

vi. Subject Jigsaw:Doymus (2007) developed the Subject Jigsaw. It is also used in group-based learning in which students need to cooperate with their peers in order to achieve personal goals. Each student is like a piece of puzzle who needs to understand and learn the subject completely (Fini, Zainalipour & Jamri, 2012).

2.6.1 Jigsaw Classroom Environment

The steps for implementing the jigsaw technique in a classroom varies depending on the type. However, the following is practiced generally. First, teachers create small heterogeneous groups with students representing multiple ability levels. Then, the teacher appoints a group leader to be in charge of the group's tasks. Next the teacher assigns the group several tasks, depending on the number of students in each group. Each student is in charge of completing a separate task. The teacher allots a certain amount of time for students

to complete their tasks or become familiar with material. Then, students from different groups who have the same tasks work together temporarily to become "experts" on their topic and fill in any gaps in their information. Original group members come back together and each member presents his/her own information and provides an opportunity for rest of group to ask questions. While students are teaching each other about the topic, the teacher moves around the room monitoring progress and answering any questions that students have about the topics. Finally, students are assessed on the material they have all learned through their cooperative learning.

Research suggests that jigsaw is used across all grade levels from K-16 to graduate and professional courses in various content areas. Since the creation of jigsaw, several modifications have been introduced to account for concerns of both teachers and students who have participated in the classroom technique.

In Jigsaw II, students carry out research in specific topics as opposed to parts of one larger reading. This variation of the original technique also requires that students complete "expert sheets" that provide notes for introducing the topic back to base group and are given individual assessments as opposed to a group evaluation (Holliday, 2002). Jigsaw III allows for a review process prior to assessment. Jigsaw IV has several additional features: teacher introduction of material; expert group quizzes; review process prior to individual assessment; and re-teaching of any material that wasn't adequately explored in the collaborative group work (Holliday, 2002).

2.6.2 Jigsaw Procedure

Generally, the Jigsaw is implemented by the following procedure:

1. Divide students into 5- or 6-person jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race, and ability.
2. Appoint one student from each group as the leader. Initially, this person should be the most mature student in the group.
3. Divide the day's lesson into 5-6 segments.
4. Assign each student to learn one segment, making sure students have direct access only to their own segment.
5. Give students time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it.
6. Form temporary "expert groups" by having one student from each jigsaw group join other students assigned to the same segment. Give students in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.
7. Bring the students back into their jigsaw groups.
8. Ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification.
9. Float from group to group, observing the process. If any group is having trouble (e.g., a member is dominating or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it.
10. At the end of the session, give a quiz on the material so that students quickly come to realize that these sessions are not just fun and games but really count.

2.7 Retention in Junior Secondary School Geometry

Bichi (2001) defined retention as the ability to retain and recall information or knowledge gained after learning. However, many researchers have investigated and defined several variables that affect knowledge retention.According to Bichi (2002), retention is the ability to retain and consequently remember things, experiences on what is learnt by an individual at a later time. Retention can also be described to be a form of reaction to what has been presented in the past. Hornby (2005) in the oxford Advanced learners' dictionary defines retentions as the ability to remember things. When concepts are taught, the ultimate desire of the teacher is that concept taught be remembered. Lakpini (2006) in her conception of retention sees it as the ability of the memory to store information which can be retrieved after being exposes to a series of instruction and training Obeka (2010) state that factors that aid retention include the type and content of task to be learned, amount of original learning, instrumental strategy used and length of retention. For the purpose of this study, retention is defined as the ability to recall the knowledge of geometry leant when required.

2.7.1 Retention and academic performance

In promoting greater performance, some studies reported that co-operative learning also foster greater retention of learners as indicated by student's results (Tran, 2014) the consistent elaboration of learning concepts or those who give the explanation with a deep understanding and a more complete retention of the concept being learnt for a longer period of time (Chiason, Kurumeh & Obida, 2010)

Iji, Ogbole and Uka (2014) conducted a study and concluded that his adoption of appropriate method(s) of teaching generally and in particular at the geometry classroom has shown to

improve student's achievement. This was clearly shown since the utilization of improvised instructional material enhanced student's retention and achievement in geometry.

2.8 Overview of Related Studies

This section specifically reviews some empirical studies carried out cooperative learning, Jigsaw cooperative learning strategy, lecture method of instruction and guided discovery method respectively. A critique of some these studies are very valuable to the present study.

Timayi, Bolaji and Kajuru (2015), investigated the effects of Jigsaw IV cooperative learning strategy (J4CLS) on the performance of senior secondary school students in geometry. The study was guided by two research questions andtwo hypotheses. The quasi experimental researchdesign involving a pretest and posttest was used. Thepopulation of the study comprised of 4624 seniorsecondary school year two (SS2) students of the publicsecondary schools in Zaria Educational Zone, Kaduna State. Twocoeducation schools were selected by the simplerandom sampling as the schools sampled for the study.The sample of students for the study comprised of 144students from two schools from intact classes(Experimental = 72 and Control = 72). One instruments namely: The GeometryPerformance Test (GPT) was used as instrument forcollecting data. The research questions wereanswered using descriptive statistics while thehypotheses were analyzed by the t-teststatistics at $P \leq 0.05$ level of significance. The study revealed a significantdifference in performance in favour of studentsexposed to the J4CLS. With regard to genderperformance, no significance difference was found.The study concludes that the J4CLS is gender friendlyand effective in the teaching and learning of geometry.

This study was well researched using an appropriate research design. The sample used met the criteria for the design. The instrument and statistical tool utilized was sufficient. The

present study is on Jigsaw II cooperative learning and guided discovery. This makes it unique. Gender is a variable that is common to both studies. The present study is interested in the retention of students which was not considered in the study under review.

Another study by Gambari and Olumorin (2013) on the other hand investigated the effectiveness of video-based CLS on high, medium and low achievers in mathematics (geometry). The study was conducted in Nigeria on 120 senior secondary school students grouped into cooperative, competitive, individualized and conventional teaching strategies. The pretest posttest research design was utilized and two research instruments namely: Video Instructional Package (VIP) and the Geometry Achievement Test (GAT) was used to collect data. The analysis of variance (ANOVA) and the Scheffe's test were used in the analysis of data. The study revealed a significant difference in the performance of students in favour of the CLS group and concludes that CLS be adopted by teachers of mathematics to improve students' performance to bridge the gap among high, medium and low achievers. The study under review is laudable in its comparison of low, medium and high achievers in geometry with respect to Video-based CLS. However, the use of such methods may be limited due to high cost of set-up.

The present study considered a more realistic method to the teaching and learning of geometry. It also compared performance and retention of student using both the Jigsaw and guided discovery approach. The present study also used ANOVA in the analysis of data.

Tran (2014) carried out a study on CLS on the academic achievement and knowledge retention among students. This study used a "convenient sample" (Creswell, 2009) of 110 primary education students from two intact classes in Faculty of Education at An Giang University. One class ($n_1 = 55$) acted as the experimental group, and another class ($n_2 = 55$)

acted as the control group. The pretest-posttest non-equivalent comparison-group design and a sample of 110 first-year primary education students split into two groups: experimental (n = 55) and control (n = 55) participated and were taught by the CLS and lecture method respectively. The study revealed that the experimental group had higher scores on achievement and knowledge retention posttest than the control group. The authors concluded that CLS stimulates cognitive activities, promotes higher level of achievement and knowledge retention.

CLS was recommended as an alternative instructional pedagogy. The author suggested that the role of CLS in the integration between branches of mathematics be investigated. This study considered CLS in performance and retention. The research design and sample were appropriate although the study was carried out in primary schools. This study closely relates to the study at hand. However, performance with respect to gender was not compared. Also, the current study is interested in both gender performance and retention of students in geometry.

Akanmu and 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. A sample of 202SS1 students were selected from two public co-educational schools in Ejibo LGA of Osun state participated in the study. The research design used was the quasi-experimental based. One instrument tagged Mathematics Achievement Test was used to collect data. The results revealed a significant difference in favor of those exposed to Guided-Discovery strategy. In addition, it was observed that both male and female students performed equally well when taught using Guided-Discovery strategy. This study was latent about the retentive ability of students exposed to the guided

strategy. However, the present study considered this and gender performance. A major feature of the present study is its comparison of Jigsaw II and the guided discovery methods which makes it unique.

Another study by Maikudi (2015), investigated the effect of Problem Solving and Guided Discovery instructional strategies on JSS Students performance and attitude in Kaduna State. The quasi-experiment design with a 3x2 factorial analysis on a pretest-posttest control group was used. The sample consisted of 381 (195 males and 186 female) students drawn from a population of 6,431students of Government Junior Secondary School using the stratified random sampling method. The research instruments used were: Geometry Performance Test (GPT) and Students Geometry Attitude Questionnaires (SGAQ). The hypotheses were tested and analyzed using t-test ANOVA, ANCOVA and Kruskal Wallis Statistics. Post Hoc Scheffe's and Least Significant Difference (LSD) were used to detect the source, magnitude and direction of such significant variations at $P< 0.05$ 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 exists 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. 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.

The study under review was well researched using appropriate instruments and analytic procedures. It is similar to the present since it compared two distinct teaching approach. However, students' retentive ability was not emphasized. The Jigsaw II method also incorporates problem solving even though as a team work before independency is established. This study is quite helpful to the one at hand.

In a study by Udo (2011) on the relative effectiveness of problem-solving, guideddiscovery, and expository methods of instruction, the students' performance in redox reaction and mathematics ability was considered. The quasiexperimental research using non-randomized-pre-test–post-test control group design with expository method as control was used on a sample of 120 SS2 chemistry students drawn from three (3) coeducational public secondary schools in Uyo Local Government Area of Akwa Ibom State, Nigeria. The criterion sampling technique was used in selecting the sample. Two researcher- developed tests – Chemistry Achievement Test (CAT) and Mathematical Ability Test (MAT), with reliability indices of 0.76 and 0.68, respectively, determined using test-retest method were used in collecting relevant data. After investigations, the results showed that those taught using problem-solving method performed significantly better than those taught with guided-discovery and expository methods with the expository approach being the least facilitative. Students' performance was observed not to be dependent on their mathematics ability. Consequently, it has been recommended that Chemistry teachers should always adopt problem-solving teaching approach in teaching redox reaction and other quantitative concepts in chemistry in

view of its high facilitative effect on the students' performance. This study considered and compared three methods of teaching. The present study compare two methods Jigsaw II and guided Discovery.

2.9 Implications of Literature Reviewed to the Present Study

Lecture method of instruction has been ineffective for teaching Geometry in junior secondary schools. For example, Ismail (2014) reveals that year two junior secondary school students lack interest in geometrical concepts taught using lecture method. Isoho (2014) and his investigations on senior secondary school students' year two had the same result as Ismail (2014). But Charlton (2006) believes thatlectures method improves learning and makes it more memorable. This view is supported by Kaur (2011) have the same notion.

Emma-Iwuoza (2014) made his investigation in the primary school, Tran (2013), Hossain et al (2013), Suleiman (2014) and Yaji (2014) in secondary school all revealed that cooperative method of instruction has positive effects on mathematics students' academic performance than the lecture of instruction. But Sengal et al (2014) reveals that the Jigsaw cooperative method of instruction has no effects on primary school students' mathematic academic achievement.

Investigations carried out by Allahoki (2012), Matthew et al (2013), Otiende et al (2013) and Olibe et al (2013) reveals that discovery method of instruction is effective in teaching of secondary school mathematics, thus there is need to investigate effects of lecture, guided discovery and Jigsaw cooperative method of instruction and junior students' year one academic achievement in geometry.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The effect of instructional methods on students' performance in geometry among junior secondary schools wasinvestigated in this study. This chapter discussed the methodology used in carrying out the study under the following sub-headings:

3.2. Research Design

3.3 Population of the Study

3.4 Sample and Sampling Technique

3.5 Instrumentation

3.6 Validation of the Instruments

3.7 Pilot Testing

3.8 Reliability of the Instruments

3.9 Administration of the Instruments

3.10 Data Collection Procedure

3.11 Procedure for Data Analysis

3.2 Research Design

This study adopted the quasi-experimental pre-test, post-test and post posttest design involving two experimental groups (**EG1 and EG2**) and one control group(**CG**).All three groups were pretested before the administration of treatment. The essence of this was to ensure homogeneity in performance at entry point. The treatments Jigsaw II Method of Instruction ($\mathbf{X_1}$) and Guided Discovery Method of Instruction ($\mathbf{X_2}$) wasadministered to students in the experimental group only; while students in the control group will be taught

using the lecture method. A Posttest was administered after treatment to all the three groups of students to determine their performance and a post posttest was also be administered to compare their retention levels in all the groups. Three intact classes were used, this is because the intact classes give better pedagogical authenticity and has less disruption of a school's day-to-day activities (Beaudry & Miller, 2006).Figure3.1 shows an illustration of the design.

$$\mathbf{EG1} \rightarrow \boldsymbol{O_1} \quad \rightarrow X_1 \rightarrow \boldsymbol{O_2} \quad \rightarrow \boldsymbol{O_3}$$
$$\mathbf{EG2} \rightarrow \boldsymbol{O_1} \quad \rightarrow X_2 \rightarrow \boldsymbol{O_2} \quad \rightarrow \boldsymbol{O_3}$$
$$\mathbf{CG} \rightarrow \boldsymbol{O_1} \quad \rightarrow X_3 \rightarrow \boldsymbol{O_2} \quad \rightarrow \boldsymbol{O_3}$$

Figure 3.1: Research Design Illustration

Where:

EG1 = Jigsaw II Method of Instruction (J2MI)

EG1 = Guided Discovery Method (GDMI)

CG = Lecture Method of Instruction (LMI)

O_1 = Pre-test

O_2 = Posttest

O_3 = Post-posttest

X_1 = treatment for experimental group (J2MI)

X_2 = treatment for experimental group (GDMI)

X_3= treatment for control group (Lecture method)

3.3 Population of the Study

The population of the study comprisedof all the Junior Secondary School two (JSS2) students of the public junior secondary schools of Zaria Educational Zone. This zone has twenty-seven (27) Junior Secondary Schools. The total enrollment as at 2016 was given as six

thousand, four hundred and fifty-four (6,454) students. This figures accounts for students in 18 co-education, 3 male and 6female schools scattered across Sabon-Gari and Zaria Local Government Areas (LGAs). These LGAs have the characteristics features that are of interest to the researcher such as student population; co-education schools and geographical spread.Table 3.1 shows the schools in the Zone, their location, the number of male and female students' enrolment per school and the total number of enrolment per school. It also, shows the category of school type each school belongs to.

Table 3.1: Population of the Study

S/No	School	Location	Sex		Total	
			Male	Female		School Type
1	GJSS Aminu	S/ Gari	130	96	126	Co-education
2	GSS T/ Jukun	T/ Jukun	98	212	310	Co-education
3	GSS K/ Jatau	Zaria City	163	137	300	Co-education
4	GJSS Zaria	Zaria City	0	220	220	Girls
5	GJSS Bogari	Zaria City	40	410	450	Co-education
6	GJSS Yakasai	Zaria City	64	35	99	Co-education
7	GSS K/ Kuyambana	Zaria City	220	90	310	Co-education
8	GJSS K/ Doka	Zaria City	372	228	600	Co-education
9	GJSS Aba	Zaria	29	02	31	Co-education
10	GJSS Muchia	S/ Gari	150	100	250	Co-education
11	GJSS Matari	Zaria	25	03	28	Co-education
12	GSS Dinya	Dinya	35	12	47	Co-education
13	GJSS Chikaji	S/ Gari	120	95	215	Co-education
14	GJSS Gimba	Zaria	44	16	60	Co-education
15	GSS Dakace	Dakace	136	54	300	Co-education
16	GGJSS Pada	Zaria City	0	300	300	Girls
17	GGJSS D/ Bauchi	S/ Gari	0	514	514	Girls
18	GJSS Gyallesu	Gyallesu	108	42	150	Co-education
19	GJSS Sai K/ Karua	Zaria City	174	156	330	Co-education
20	GJSS Kinkiba	Kinkiba	40	08	48	Co-education
21	GSS Chindit Junior	S/Gari	0	340	340	Girls
22	Barewa College	Gaskiya	295	0	295	Boys
23	GJSS K/ Gaya	Zaria City	0	270	270	Girls
24	GJSS Chindit Boys Junior	S/ Gari	370	0	370	Boys
25	GJSS Magagia	Zaria	112	39	151	Co-education
26	GGSS (WTC)	Zaria	0	150	150	Girls
27	GSS Ahhudahuda	Zaria City	200	0	200	Boys
	Total		**2925**	**3529**	**6454**	

Source: Zaria Educational Zone (2017)

3.4 Sample and Sampling Techniques

The three schools were selected using the simple random sampling from the coeducation school to avoid research bias that may arise from the single sex schools. The schools are GJSS Dakachi, GJSS Gyellesu and GJSS Tudun Jukun,The sampled schools were located in such a way that subject could not easily get in touchwith each other as a way of reducing interaction. The schools were also randomly placed into experimental and control groups using the simple random sampling method. In each school, one intact class was randomly selected using the sample random method as the class for the study. The use of intact classes for this study was because school administration will not allow for randomization of subject. Also, Beaudry and Miller (2006), asserted that intact classes give better pedagogical authenticity and has less disruption of a school's day-to-day activities. The ages of the student ranges between 12 to 16 years of age. The sample for the study is shown in Table 3.2. The sample for the study is thus 194 students (95 male and 99 female).

Table 3.2: Sample to the Study

S/No	School	Status	Male	Female	Total
1	GJSS Dakachi	Experimental 1	30	34	64
2	GJSS Gyellesu	Experimental 2	34	32	66
3	GJSS Tudun Jukun	Control	31	33	64
	Total		**95**	**99**	**194**

3.5 Instrumentation

Two instruments were used in this study namely the Geometry PerformanceTest (GPT) and the Geometry Retention Test (GRT).

3.5.1 Geometry Performance Test (GPT)

GPT is a forty (40) item,5 multiple choice objective testmultiple-choicequestions having options A – E developed by the researcher from past question papers of JSCE and the New General Mathematics (NGM) for JSS2 covering questions and units of geometry (see appendix 1).

3.5.2 Geometry Retention Test (GRT)

GRT is also a forty (40) item, 5 multiple choice objective testmultiple-choice questions having options A – E developed by the researcher from the GPT. It is an equivalent test to the GPT; where some questions in it had their numbers and answers changed so that students will not be able to guess their answers at a glance (see appendix 2).

3.6 Validity of the Instruments

The test items werevalidated by three mathematics educators. Two were Ph.D. holders and senior lecturers in the Department of Science Education, Ahmadu Bello University, Zaria. These experts were chosen because of their wealth of experience. While the last was a secondary school mathematics teacher with 10 years teaching experience in the secondary school having a Masters of Education Degree (M. Ed) in mathematics education. These experts were requested to:

1. Study the instrument and certify if the questions were suitable for testing academic achievement.
2. Certify if the Item are appropriate for the level of the students under study.
3. Check for possible errors in the instrument and suggest corrections.
4. Whether the question adequately covers the syllabus.

Their criticism and observation were incorporated into the test items. For instance, where the researcher wrote mathematics, geometry was used instead so that questions or statements put up was more meaningful and precise.

3.7 Reliability of the Instruments

The reliabilities of Geometry Performance Test (GPT) and Geometry Retention Test (GRT) were ascertained separately.

3.7.1 Reliability of Geometry Performance Test (GPT)

The test-retest reliability method was used determine the reliability of GPT. It was found to be 0.82 when the Pearson Product Moment Correlation (PPMC) was observed. Therefore, GPT was deemed reliable.

3.7.1 Reliability of Geometry Retention Test (GRT)

In ascertaining the reliability of GRT, the test-retest method was used. A reliability value of 0.79 was obtained with the PPMC. Hence, GRT can be used for the study.

3.8 Pilot Testing

A Pilot test was conducted with forty (40) students (20 male and 20 female) of JSS2 in GJSS Bomo which was not within the proximity of the selected schools for the study to test the appropriateness of the GPT. This test facilitated the determination of the appropriate timing for each test and also problems which may affect the effective administration of the instruments to students in the actual research. GPT took 55 minutes, the scores obtained from the pilot-test facilitated the determination of the reliability of the instruments which is a measure of their respective internal consistencies.

One of the problems the researcher encountered during the pilot study was that of organizing the students and getting them to participate. However, the researcher with the assistant of

research assistants were able to get them organized for the testing of the instruments. Also during the day scheduled for the retention test, some students were absent so the test was postponed by two days. The problems were addressed the same way during the main research.

3.9 Administration of the Instruments

There were three groups, two experimental and one control groups. All groups were pretested before treatment. Thereafter, experimental group 1 was taught using the Jigsaw II Method of Instruction (J2MI) while experimental group 2 was taught the Guided Discovery Method Instruction. However, the control group was taught using the lecture Method of Instruction (LMI). The treatment period lasted for a period of six weeks after which all the groups were Post tested to compare their performance. A post-posttest was administered to the students in the three groups within an interval of three weeks to determine their retention level.

3.9.1 Teaching Experimental Group1

The procedure for teaching experimental group 1 students is given in appendix 3. The steps are outlined and a flow chart of the steps is also presented. The lesson plan and expert sheet for the expert group is also given in appendix 6.

3.9.2 Teaching Experimental Group2

The procedure for teaching experimental group 2 students is presented in appendix 4. The steps are outlined and a flow chart of the steps is also given. The lesson plan for teaching the guided discovery method is given in appendix 7.

3.9.3 Teaching Control Group

Appendix 5 presents the procedure for teaching the control group who were taught geometry using the lecture method of instruction. The lesson plan for teaching this group is presented in appendix 8

3.9.4 Method of scoring

The marking and scoring of the pre-test and posttest was done by the researcher. The researcher used the marking scheme. Each of the 40 questions carries one mark. After marking, the respective score of each student was multiplied by 4 to make it 100%. After the treatment was over, posttest was administered to all the three groups. Pretest served as data to equate the control and the experimental groups. Post-test score served as a data to measure academic performance of the sampled subject. Researcher marked the script using carefully prepared and validated marking guide to ensure uniformity in scoring. The scores were recorded based on the groups.The scores from the three groups was subjected to statistical analysis.

3.10 Procedures for Data Analysis

The research questions were answered using the mean and standard deviation scores obtained from the Geometry Performance Test scores. Hypotheses one was tested using analysis of variance (ANOVA) at $P \leq 0.05$ level of significance. Hypotheses two and three were tested

using the t-test statistics at P≤ 0.05 level of significance. Hypothesis four was analyzed using the analysis of variance (ANOVA) at P≤ 0.05 level of significance.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter dealt with the data presentation, analysis and discussion of the study effects of Jigsaw II and guided discovery methods on retention and academic performance in geometry among junior secondary school students in Zaria metropolis. The study aimed at assessing the retention and academic performance of students in geometry when exposed to Jigsaw and guided discovery methods. Descriptive and statistical analysis of data collected were presented. The testing of the research hypotheses was carried out in the course of the presentation to enable the researcher draw some conclusions and make recommendation. The procedure is presented under the following headings;

4.2 Data Analysis and Results Presentation

4.3 Summary of findings

4.4 Discussions

4.2 Data Analysis and Result Presentation

The data collected from the study using the instrument were analyzed, the result obtained was used to answer the research questions and testing the hypotheses. This section is divided into two; answers to research questions (section 4.2.1) and testing hypotheses (section 4.2.2)

4.2.1 Answers to Research Questions

This section presented the answers to the research questions asked in section 1.4

Research Question 1

What is the difference between the performance of students taught geometry using Jigsaw, guided discovery and lecture methods of instruction?

Table 4.1: Descriptive Statistics for Performance between Experimental Group 1, Experimental Group 2 and Control Group

Group	N	Mean	SD
Experimental 1	64	52.55	11.12
Experimental 2	66	49.03	13.21
Control	64	33.17	16.056

Table 4.1 presented the mean scores and standard deviation scores of the Experimental Group1, Experimental Group 2 and Control group respectively. Experimental Group 1 had a higher mean score of 52.42 compared to that of the Experimental Group 2 who had a mean score of 49.03 and the control group who had 33.17. Also, the Experimental Group 1, Experimental Group 2 and Control group had a standard deviation score of 11.12, 13.21 and 16.06 respectively. This implies that there is a difference in the mean and standard deviation of the three groups.

Research Question 2

What is the difference between the performance of male and female students taught geometry using Jigsaw method?

To answer this question, the descriptive statistics was used as shown in Table 4.2

Table 4.2: Descriptive Statistics for Performance between Male and Female Students in Experimental Group 1

Gender	N	Mean	SD
Male	30	51.67	11.18
Female	34	53.09	11.33

Table 4.2 revealed that female students had a higher mean score of 53.09 and their male counterpart had a mean score of 51.67. Their standard deviation scores were 11.18 and 11.33 respectively.

Research Question 3

Is there any difference between the performance of male and female students taught geometry using guided discovery method?

The descriptive statistics was used to answer this question as shown in Table 4.3

Table 4.3: Descriptive Statistics for Performance between Male and Female Students in Experimental Group 2

Gender	N	Mean	SD
Male	34	47.21	6.58
Female	32	49.13	6.62

Table 4.2 presented the descriptive statistics of the mean scores and standard deviation scores of male and female students who learnt geometry by the guided discovery method only. The result showed that the male students had a lower mean score of 47.21 than the female students who had a mean score of 49.13. Also, the male and female students had a standard deviation scores of 6.58 and 6.62 respectively.

Research Question 4

What is the difference between the retention level of students taught geometry using the Jigsaw method of instruction, the guided discovery method of instruction and the lecture method?

The descriptive statistics presented in table 4.4 was used in answering this question

Table 4.4: Descriptive Statistics for Retention Level between Experimental Group 1, Experimental Group 2 and Control Group

Group	N	Mean	SD
Experimental 1	64	52.66	7.42
Experimental 2	66	41.21	6.67
Control	64	27.95	8.92

The summary of the retention scores presented in Table 4.4 revealed that the experimental group (1) had a higher mean retention score of 52.66 compared to the experimental group (2) and the control group who had retention scores of 41.21 and 27.95 respectively. The respective standard deviation scores are found to be 7.42, 6.67and 8.92.

4.2.2 Testing of Hypotheses

This section presented the testing of the null hypothesis stated in section 1.5 at $p \leq 0.05$ level of significance. The analysis of the result is presented as follows.

Null Hypothesis 1

There is no significant between the performance of students taught geometry using J2MI, GDMI and LM strategies of teaching.

To test this hypothesis, the scores obtained from the geometry performance test (Table 4.1) of the experimental group (1), experimental group (2) and control group were subjected to one way analysis of variance (ANOVA) at $\alpha = 0.05$ shown in Table 4.5.

Table 4.5: Summary of Analysis of Variance (ANOVA) for Performance between Experimental Group 1, Experimental Group 2 and Control Group

Source	Sum of Squares	df	Mean Squares	F-value	P-value	Remark
Between Groups	13637.76	2	6818.88	36.79	0.001*	Reject HO1
Within Groups	35026.91	189	185.33			

*Significant at $p < 0.05$

From Table 4.5, the F-value of 36.79 has a corresponding P-value of 0.001. The P-value of 0.001 was found to be less than the stated P-value of 0.05 level of significance. Hence, it is significant. Consequently, the null hypothesis one (H_{01}) was rejected. This means that there is significance between the performance of the experimental group 1, experimental group 2 and control group.

To determine where the difference lies, the data was subjected to the Scheffes' Post Hoc test of multiple comparisons. This is presented in Table 4.6

Table 4.6: Summary of Scheffe's Post Hoc Test for Multiple Comparison of Performance between Experimental Group 1, Experimental Group 2 and Control Group

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	P-value	Remark
Experimental 1	Experimental 2	3.516	2.407	0.346**	NS
	Control	19.375	2.407	0.001*	S
Experimental 2	Experimental 1	-3.516	2.407	0.346**	NS
	Control	15.859	2.407	0.001*	S

*Significant at $p \leq 0.05$, ** Not Significant at $p > 0.05$

Table 4.6 showed that a significant difference lies between the performance of students in experimental group 1 and control group. Also, a significant difference is observed between

the performance of students in experimental 2 and the control group. However, between the experimental groups (1 & 2) the difference was not significant.

Null Hypothesis 2

There is no significant between the performance of male and female students taught geometry using J2MI.

To test this hypothesis, the mean scores obtained from the geometry performance test in Table 4.2 of male and female students in the experimental group 1 was compared using the independent t-test statistics and presented in Table 4.7

Table 4.7: Independent t-test for Performance between Male and Female Students in Experimental Group 1

Source	N	Mean	df	t-Value	P-Value	Remark
Male	30	51.67				Retain
			62	0.504	0.616**	HO2
Female	34	53.09				

** Not Significant at P> 0.05

Table 4.7 revealed that a P-value of 0.616 was obtained from the t-value of 0.504 at 62 degrees of freedom. This value is not significant since P = 0.616 is greater than P = 0.05 level of significance. Therefore, the null hypothesis two (H_{02}) was retained. This implied that there was no significance between geometry performance of male and female students in experimental group 1 when exposed to J2MI. The result therefore showed that the J2MI is a gender friendly teaching method.

Null Hypothesis 3

There is no significant between the performance of male and female student taught geometry using GDMI.

This hypothesis was analyzed using the mean scores in geometry performance test (Table 4.3) of the experimental group (2). This is shown in Table 4.8.

Table 4.8: Independent t-test for Performance between Male and Female Students in Experimental Group 2

Source	N	Mean	df	t-Value	P-Value	Remark
Male	34	47.21				Retain
			62	1.81	0.2426**	HO3
Female	32	49.13				

** Not Significant at P> 0.05

From Table 4.8, a p-value of 0.242 was obtained from the t-value of 1.81 at 62 degrees of freedom. This value is not significant since P = 0.242 is greater than p = 0.05 level of significance. Therefore, the null hypothesis three (H_{03}) is hereby retained. This implies that there is no significance between the geometry performance of male and female students in experimental group (2) when exposed to guided discovery method. It is gender friendly.

Null Hypothesis 4

There is no significant between the retention level of students taught geometry using Jigsaw method of instruct guided discovery method and the lecture method.

To analyze this hypothesis, the retention mean scores of students (Table 4.4) of students in the experimental group (1), experimental group (2) and control group was subjected to the analysis of variance (ANOVA) at $p \leq 0.05$ as shown in Table 4.9.

Table 4.9: Summary of Analysis of Variance (ANOVA) for Retention Level between Experimental Group 1, Experimental Group 2 and Control Group

Source	Sum of Squares	df	Mean Squares	F-value	P-value	Remark
Between Groups	1949.54	2	9709.77	163.17	0.001*	Reject HO4
Within Groups	11365.64	191	59.51			

*Significant at $p \leq 0.05$

Table 4.9 revealed that the F-value of 163.17had a P-value of 0.001 which is significant at $p \leq 0.05$. Therefore, the null hypothesis four is hereby rejected. Hence, it is concluded that there exists a significant difference between the groups in terms of retention level. In order to ascertain which of the groups is significantly different from the others the data was subjected to Scheffes' Post Hoc test for multiple comparisons. This is presented in table 4.10.

Table 4.10: Summary of Scheffe's Post hoc Test for Multiple Comparison of Retention between Experimental Group 1, Experimental Group 2 and Control Group

(I) Group Retention	(J) Group Retention	Mean Difference (I-J)	Std. Error	P-value
Experimental Group 1	Experimental Group 2	11.350*	1.353	0.001
	Control	24.609*	1.364	0.001
Experimental Group 2	Experimental Group 1	-11.350*	1.353	0.001
	Control	13.259*	1.353	0.001

Table 4.10 revealed that the multiple comparison of students' retention level in the experimental group (1), experimental group (2) and the control group was significant at $p \leq 0.05$. All three groups' retention ability was significantly different. However, the students taught using the J2MI retained best.

4.3 Summary of Major Findings

The data collected were analysed to answer four research questions and test four null hypotheses formulated in section 1.4 and 1.5 of this study respectively. From the data analyzed the following findings were observed.

1. There was a significant difference between the mean performance scores of students taught geometry using the Jigsaw II cooperative learning strategy, the guided discovery method and lecture method of instruction. This follows from the interaction among students in the learning process. The J2MI for instance breaks inferiority complex and promotes learning among students.
2. There was no significant between the mean performance score of male and female students taught geometry using Jigsaw II cooperative learning strategy. It was observed that male and female students work together in the classroom which exposes them to collaboration resulting in similar performance.
3. There was no significant between the mean performance score of male and female students taught geometry using guided discovery method. This is also a consequence of exposure in the classroom situation among students which enable an environment of participation.
4. There was significant between the retention level of students taught geometry using Jigsaw II cooperative learning strategy, guided discovery method and lecture method. The interaction between students gave rise to this. The more participation, the more retention is enabled.

4.4 Discussions

The aim of this study was to assess the effects of Jigsaw II and guided discovery strategies on retention and performance in geometry among junior secondary school students in Zaria Metropolis, Nigeria. Four topic namely; properties of quadrilaterals, angles between lines, angles in triangle and quadrilaterals, angles in polygons were examined in the study. The students in the experimental group (1), experimental group (2) and the control group used in the study had equivalent knowledge of geometry. The differences observed were due treatment. The result of data on research questions and null hypothesis tested are discussed as follows:

The result in Table 4.1 showed that there is difference in the mean and standard deviation scores of the experimental group (1), experimental group (2) and the control group in favour of the experimental group (1). This difference was subjected to one way analysis of variance in Table 4.5. The Table revealed that the difference observed was significant. This implied that the use of Jigsaw II cooperative learning strategy improved students' academic performance in geometry.

This finding is in line with that of Timayi et al (2015) who found out that the Jigsaw II method of instruction improves students' performance in geometry due to the interaction among students. It also agrees with Maikudi (2015) who observed that when students are taught using an interactive pedagogical approach which is students centered such as Jigsaw, problem solving guided discovery etc their test scores and academic performance is enhanced. This is because when students are not passive in their learning, they are observed to perform best.

The result obtained from Table 4.2 revealed a higher posttest man performance some for the female students compared to that of the male students. However, when this difference was

subjected to t-test analysis, theobserved difference was not significant. This finding was in agreement with Gambari and Olumorin (2013) and Timayi et al (2015) who observed that when appropriate method of instruction is used in teaching geometry, gender gaps and issue of varied achievement is removed. Students are observed to perform similarly irrespective of their gender and background. Moreover, it has been observed that the mathematics gap once reported between male and female students is now being bridged with good teaching methodology hence more female students take on careers once dominated by their male counterpart.

Table 4.3 presented the respective summary of the mean and standard deviation scores of male and female students exposed to the guided discovery strategy. The Table revealed that the males had a lower mean score when compared to that of their females' counterpart. The observed difference was found to be non-significant when further analysis was carried out. This finding confirms the findings ofUdo (2011), Akanmu and Fajemidagba (2013) and Maikudi (2015) who observed that both male and female students performed equally well when taught using Guided-Discovery strategy. This is a consequence of the constructivism learning process. Students' learning when is activity based can enhance the performance of male and female students similarly.

When the retention ability of the groups was compared, is was observed that the students taught using the Jigsaw II method retained more followed by those taught by the guided discovery method. The lecture group retained least. This implied that the Jigsaw II cooperative learning strategy enhances retention level of students significantly. This agrees with Tran (2014), Timayi et al (2015) who asserted that Cooperative learning strategies such as Jigsaw stimulates cognitive activities, promotes higher level of achievement and

knowledge retention. Both Jigsaw and Guided discovery strategies gives room to students to explore various techniques of problem solving which in turn enhances their performance in school based subjects.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study determined the effects of Jigsaw II and guided discovery methods on retention and academic performance in geometry among junior secondary school students in Zaria metropolis of Kaduna State. The study's objective is assessing the retention and academic performance of students in geometry when exposed to Jigsaw II and guided discovery methods. This chapter summarized the whole study under the following headings: summary, conclusion and recommendations. It also gave suggestions for further research.

5.2 Summary

The issue of poor performance and retention among students for geometry at the junior secondary school level was the problem the study considered. Hence, the effects of Jigsaw II and guided discovery methods on retention and academic performance in geometry among junior secondary school students in Zaria metropolis of Kaduna State. The instructional method employed by the teacher plays an important role in the acquisition of instructional content for meaningful learning and development of necessary mathematical skills. Nigerian secondary school classrooms are predominantly dominated by the lecture (conventional) method of instruction which does not encourage student-student interaction. The lack of active participation of students is their learning was also indicted for students' poor performances in geometry. Research in many areas of education has shown that the method of teaching utilized by the teacher is an important factor in students' learning and subsequent performance in examinations. A learning strategy, which is result oriented and is capable of

improving students' retention and performance in geometry and mathematics in general at the JSS level can save the situation.

The objectives of the study were followed by appropriate research questions and hypotheses which were analyzed using appropriate statistics tools. Two (2) instruments were used for data collection; they are the Geometry Performance Test (GPT) and the Geometry Retention Test (GRT. From the study, it was observed that students taught geometry using the J2MI and the GDMI performed better than those taught the same concepts using the lecture method. The same trend was observed with retentive ability of students.

Imperatively, with alternative method of instruction, students' test scores and retention improves. The J2MI and GDMI have proved to be alternatives to the lecture method. These methods when utilized gives the students room to explore and interact with their peers leading to self-improvement. The teachers' dominance of the class is reduced to the guidance. These are feature of the constructivist where the function of cognitive is adaptive and enables the learner to construct viable explanations of experiences.

5.3 Conclusions

The study was on effects of Jigsaw II and guided discovery methods on retention and academic performance in geometry among junior secondary school students in Zaria metropolis. From the findings of the study, which was based on descriptive and statistical analyses of data collected, the following conclusions were arrived at.

The J2MI and GDMI are more effective at improving students' performance in geometry compared to the lecture method. This is evident in the higher mean performance scores obtained by students who were taught using the methods. It was also observed that the methods are gender friendly evidenced by male and female students' performances.

The J2MI and GDMI were observed to improve students' retention in geometry better than the lecture method. This follows from the higher mean score of retention obtained by the students exposed to it. It was also observed that the methods are gender friendly with regard to retention.

J2MI and GDMI can be used as alternative teaching methods for geometry pedagogy at the JSS level as shown by the findings of the study.

5.4 Contribution to Knowledge

1. The study establishes that J2MI and GDMI are superior and better than the lecture method because they are capable of improving students' performance in geometry.
2. When J2MI and GDMI were used in teaching geometry, no significant difference was found between male and female performance, hence, they are gender friendly.
3. J2MI and GDMI were observed to enhance retention.

5.5 Recommendations

Based on the findings in chapter four and the conclusions of the study, the following recommendations are made:

1. Teachers should employ the use of J2MI and GDMI as alternative to lecture method in the teaching of geometry at JSS level to enhance students' performance and retention ability. The strategies also facilitate the learning of much material in limited time which can help the teacher and students cover large portions of the school syllabus.
2. Students should be encouraged by their teachers to participate in the J2MI and GDMI because they are result oriented strategies that are have the potential of improving their performance and retention in mathematics.

3. Workshops and seminars for mathematics and science based teacher should be organized by the Ministry of Education for each Education Zone of Kaduna State on the use of the J2MI and GDMI.
4. Textbook writers should include J2MI and GDMI as methods for teaching geometry and mathematics.

5.6 Implications of findings of the Study

The findings of this study have some important implications that will be useful for the teaching and learning of geometry and mathematics in generally. They are as follows:the teaching and learning of geometry can be improved if the right methodology is employed. This is because the poor performance of students in mathematics has been linked to inappropriate methodology utilized in its teaching.

The J2MI and GDMI can be utilized. This is because they are teaching methods that are capable of producing better confidence in female students through its collaborative potential.The potential embedded in J2MI and GDMI can promote better performance and retention needed for career and individual development in other fields of endeavour among students.

5.7 Suggestions for Further Studies

1. A study on the effects of J2MI and GDMI on the academic performance, attitude and retention of students in geometry can be carried out among secondary school students, polytechnic, colleges of education and undergraduates of Universities.
2. Similar study can be carried out in secondary schools in other states of the federation to ascertain if similar findings will hold.

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Appendix 1

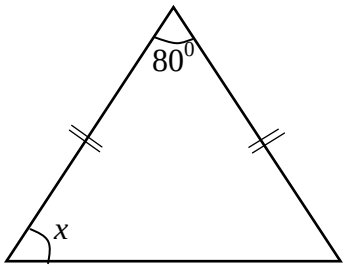
Geometry Performance Test

School …….

Age …… Sex: Male [ ] Female [ ]

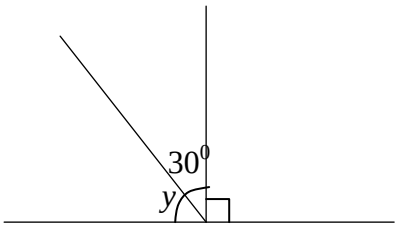
Geometry Performance Test is a multiple-choice objectives test based on units of geometry in the JSS2 syllabus. Please read each question carefully and answer the questions that follows by ticking (√) only one of the options

1. Find the value of x in the diagram below



(a) 90^0 (b) 60^0 (c) 70^0 (d) 50^0 (e) 80^0

2. The sum of angles on a straight line is (a) 45^0 (b)90^0 (c)180^0 (d) 360^0 (e) 270^0
3. A regular polygon with 6 side is called _____ (a) Heptagon (b) Hexagon (c) Pentagon (d) Nonagon (e) Quadrilateral
4. All are properties of a parallelogram, except (a) it has two diagonals (b) it has four sides (c) all sides are equal (d) sum of it's angels is 360^0 (e) it has no line of symmetry
5. A quadrilateral is a plane figure with _____ sides (a) 5 (b) 2 (c) 6 (d) 3 (e) 4
6. What is the value of Y from the figure below?



(a) 40^0 (b) 70^0 (c) 45^0 (d) 60^0 (e) 80^0

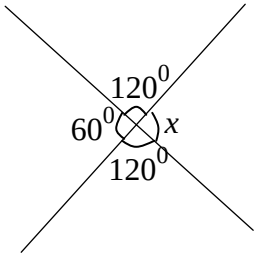
7. Octagon is a regular polygon with _____ sides (a) 5 (b) 6 (c) 7 (d) 8 (e) 9
8. What is the size of the fourth angle of a quadrilateral whose other three angles are 118^0, 64^0, 75^0? (a) 108^0 (b) 106^0 (c) 103^0 (d) 107^0 (e) 104^0

9. _____ and _____ are quadrilaterals with four equal sides (a) parallelogram and rhombus (b) rhombus and kite (c) parallelogram and kite (d) square and rhombus (e) square and parallelogram

10. The formula for calculating sum of angels of an n- sided polygon is _____ (a) $(n - 1) \times 180^0$ (b) $(n - 2) \times 180^0$ (c) $(n-3) \times 180^0$ (d) $(n - 4) \times 180^0$ (e) $(n - 5) \times 180^0$

11. How many sides does a rhombus of side 3cm has? (a) 4 (b) 6 (c) 5 (d) 3 (e) 7

12. Find the value of x in the diagram below



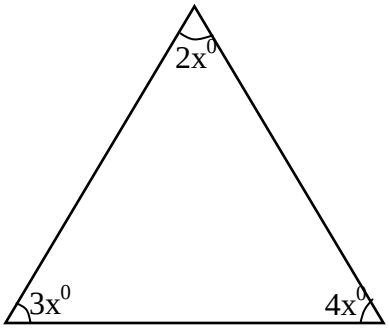
(a) 50^0 (b) 60^0 (c) 80^0 (d) 90^0 (e) 360^0

13. Find the sum of the interior angles of a polygon which has 10 sides (a) 1260^0 (b) 1440^0 (c) 1620^0 (d) 1800^0 (e) 1980^0

14. How many triangles are there in an octagon (a) 10 (b) 8 (c) 7 (d) 6 (e) 5

15. Which of the following is not a plane shape (a) circle (b) kite (c) rhombus (d) cube (e) rectangle

16. Find the largest angle in the figure



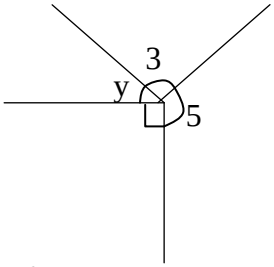
(a) 20^0 (b) 40^0 (c) 60^0 (d) 80^0 (e) 120^0

17. _____ is a plane shape with four sides (a) polygon (b) pentagon (c) heptagon (d) parallelogram (e) hexagram

18. Squares, rectangles and rhombuses are special _____ (a) kites (b) parallelogram (c) rhombus (d) circles (e) rectangles

19. _____ has no line of symmetry (a) kite (b) parallelogram (c) rhombuses (d) circle (e) rectangles

20. Find the value of Y



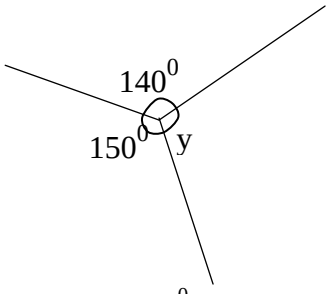
(a) 30^0 (b) 40^0 (c) 60^0 (d) 261^0 (e) 270^0

21. Which of the following triangles has all sides equal

(a) scalene triangle (b) equilateral triangle (c) isosceles triangle (d) right angled triangle (e) acute triangle

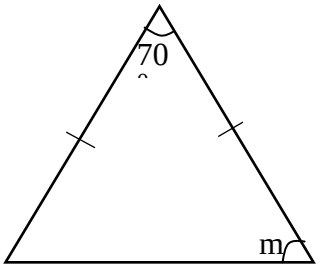
22. The sum of angles of a polygon is 22 right angles. How many sides does the polygon have? (a) 22 (b) 13 (c) 26 (d) 23 (e) 32

23.



Find the value of y in the diagram above (a) 70^0 (b) 60^0 (c) 50^0 (d) 40^0 (e) 30^0

24. The size of angle m in the figure below is _____



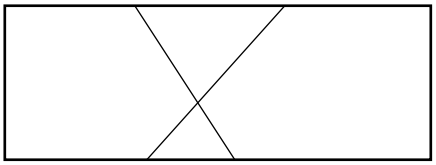
(a) 180^0 (b) 170^0 (c) 110^0 (d) 70^0 (e) 55^0

25. Sum of angles on a straight is _____ (a) 360^0 (b) 180^0 (c) 380^0 (d) 160^0 (e) 308^0

26. The angels of a quadrilateral are 24^0, $3x^0$, 120^0 and 144^0. Find x (a) 24^0 (b) 40^0 (c) 48^0 (d) 60^0 (e) 72^0

27. Find the sum of angles of a regular hexagon (a) 360^0 (b) 720^0 (d) 900^0 (e) 1440^0

28. How many quadrilaterals are in the diagram below?

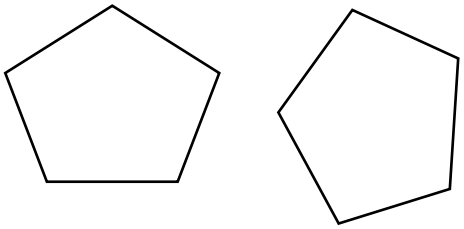


(a) 5 (b) 4 (c) 3 (d) 2 (e) 1

29. Which of the following properties is not of a Kite? (a) one pair of opposite angles are equal (b) the diagonals meet at right angels (c) there is one line of symmetry (d) there are two lines of symmetry (e) two pairs of adjacent sides are equal

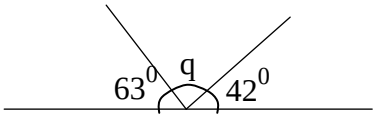
30. A line that divides a plane shape into two equal parts is called line of _____ (a) diagonal (b) symmetry (c) transversal (d) parallel (e) perpendicular

31. This figures are called _____



(a) Hexagons (b) pentagon (c) octagons (d) heptagon (e) nonagon

32. Calculate the size of angle q below



(a) 21^0 (b) 42^0 (c) 48^0 (d) 75^0 (e) 105^0

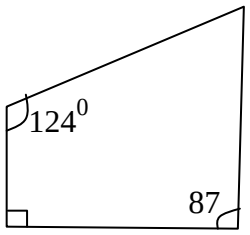
33. A decagon has _____ number of triangle (a) 8 (b) 9 (c) 7 (d) 10 (e) 6

34. When a transversal crosses parallel lines the corresponding angles are _____ (a) equal (b) opposite (c) different (d) direct (e) acute

35. Calculate the fourth angle of quadrilateral whose other three angles are 95^0, 85^0, and 90^0. (a) 105^0 (b) 100^0 (c) 195^0 (d) 185^0 (e) 110^0

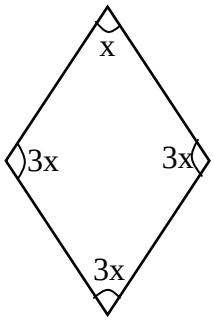
36. A triangle that have two equal sides is called _____ triangle (a) isosceles (b) equilateral (c) scalene (d) right angle (e) acute angled

37. Find the size of the unknown angle below



(a) 124^0 (b) 87^0 (c) 59^0 (d) 78^0 (e) 95^0

38. What is the value of x in the diagram below?

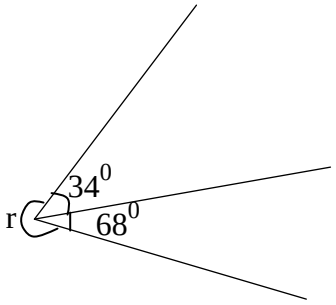


(a) 30 (b) 46 (c) 43 (d) 33 (e) 36

39. The sum of seven of the angles of a decagon is 1170^0. The other three are all equal to each other. Calculate the sizes of the other three angles (a) 135^0 (b) 153^0 (c) 315^0 (d) 125^0 (e) 152^0

40. How many sides has a polygon if the sum of it's angles is 44 right angles? (a) 44 (b) 40 (c) 20 (d) 22 (e) 90

41. Find the size of the angle marked r in the figure below



(a) 102^0 (b) 112^0 (c) 258^0 (d) 292^0 (e) 326^0

Appendix 2

Geometry Retention Test

School …….

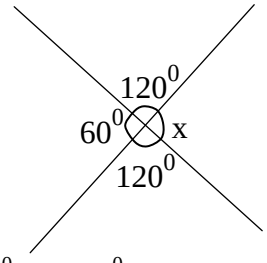
Age …… Sex: Male [ ] Female [ ]

Geometry Retention Test is a multiple-choice objectives test based on units of geometry in the JSS2 syllabus. Please read each question carefully and answer the questions that follows by ticking (√) only one of the options

1. Octagon is a regular polygon with _____ sides(a) 5 (b) 6 (c) 7 (d) 8 (e) 9
2. What is the size of the fourth angle of a quadrilateral whose other three angles are 118^0, 64^0, 75^0? (a) 108^0 (b) 106^0 (c) 103^0 (d) 107^0 (e) 104^0
3. _____ and _____ are quadrilaterals with four equal sides (a) parallelogram and rhombus (b) rhombus and kite (c) parallelogram and kite (d) square and rhombus (e) square and parallelogram

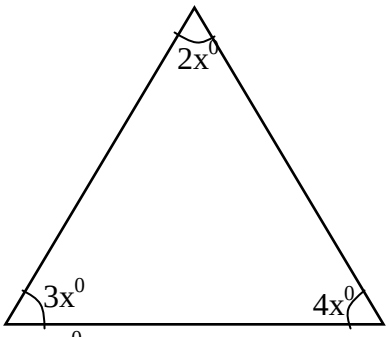
4 The formula for calculating sum of angels of an n- sided polygon is _____ (a) $(n - 1) \times 180^0$ (b) $(n - 2) \times 180^0$ (c) $(n-3) \times 180^0$ (d) $(n - 4) \times 180^0$ (e) $(n - 5) \times 180^0$

5. How many sides does a rhombus of side 3cm has? (a) 4 (b) 6 (c) 5 (d) 3 (e) 7
6. Find the value of x in the diagram below



(a) 50^0 (b) 60^0 (c) 80^0 (d) 90^0 (e) 360^0

7. Find the sum of the interior angles of a polygon which has 10 sides (a) 1260^0 (b) 1440^0 (c) 1620^0 (d) 1800^0 (e) 1980^0
8. How many triangles are there in an octagon (a) 10 (b) 8 (c) 7 (d) 6 (e) 5
9. Which of the following is not a plane shape (a) circle (b) kite (c) rhombus (d) cube (e) rectangle
10. Find the largest angle in the figure



(a) 20^0 (b) 40^0 (c) 60^0 (d) 80^0 (e) 120^0

11. _____ is a plane shape with four sides (a) polygon (b) pentagon (c) heptagon (d) parallelogram (e) hexagram

12. Squares, rectangles and rhombuses are special _____ (a) kites (b) parallelogram (c) rhombus (d) circles (e) rectangles

13. _____ has no line of symmetry (a) kite (b) parallelogram (c) rhombuses (d) circle (e) rectangles

Appendix 3

Teaching Experimental 1 (Jigsaw Method of Instruction)

The first experimental group will be exposed to Jigsaw cooperative method of instruction. Based on the result obtained from the pretest, the researcher will place students into Home Groups (HG) of 4 students with different ability each coded by alphabetic letters A, B, C … and so on as presented in Table 3.3.

Table 3.3: Home Group Plan

Group 1	Group 2	Group 3	…	Group 16
A1 A2	B1 B2	C1 C2	…	P1 P2
A3 A4	B3 B4	C3 C4	…	P3 P4

Source: Bolaji, Kajuru and Timayi (2015)

In each home group, a member was given a number A1, A2, A3, and A4. These numbers determined the Expert Group [EG] (see Table 3.4) a student consequently belonged to. Members in respective home groups with the same numbers studied a sub-topic in geometry.

Table 3.4: Expert Group Distribution Plan

EG 1	EG 2	EG 3	EG 4
A1, B1, C1, D1	A2, B2, C2, D2	A3, B3, C3, D3	A4, B4, C4, D4
E1…P1	E2, …P2	E3…P3	E4, …R4

Source: Bolaji, Kajuru and Timayi (2015)

The sub-topics were distributed according to codes (1, 2, 3 & 4). Students with the same number code were in the same expert group and consequently studied the sub-topic in the expert material (see Table 3.5 and appendix 4).

Table 3.5: Expert Groups and Sub-topics

Expert Group	Content
A1, B1, C1 … P1	Definition and properties of parallelograms, Rhombuses and Kites
A2, B2, C2 … P2	Connection and relationship between quadrilaterals and the environment.
A3, B3, C3 … P3	Angle between lines and angle in a triangle.
A4, B4, C4 … P4	Angle in a quadrilateral and angle in a polygon

Source: Bolaji, Kajuru and Timayi (2015)

Upon completion of study, all students in the Expert group returned to their Home groups in line with the Jigsaw procedure. After home group interactions, the posttest (GPT) will be administered and individual score obtained. Treatment to the experimental group 1 lasted for 60 minutes three times a week for six weeks.

The steps involved in teaching the student using the Jigsaw Method of Instruction are as follows:

Step 1: Students are placed into expert groups (EG) from their respective home groups (HG).

Step 2: The Students are assigned their expert sheets which contains all they will need to master.

Step 3: Each expert group answers their expert sheet questions or learn its content.

Step 4: Students return to their home groups for interaction with other members. They take turns to teach other members what they have mastered from their respective expert sheets.

Step 5: Students are given quiz based on the overall content they have mastered.

Step 6: End of the lesson.

The entire process is represented in a flow chart (figure 3.2).

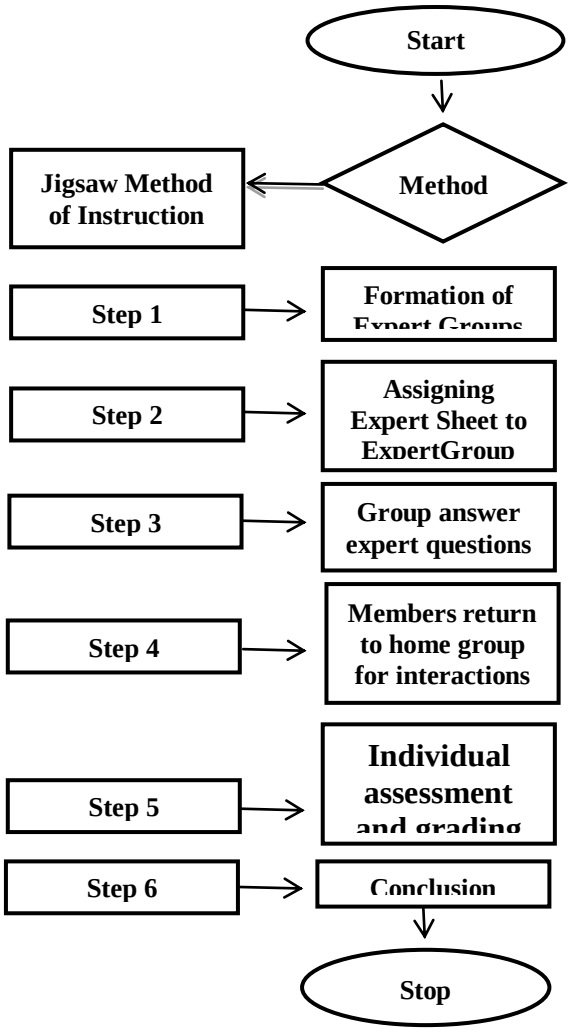


Figure 3.2: Flow Chart of Jigsaw procedure
Source: Kagan (1994)

Appendix 4

Teaching Experimental 2 (Guided Discovery Method of Instruction)

The second experimental group will be exposed to the guided discovery method of instruction to teach each topic; the researcher use their previous knowledge to form a basis for guiding student to solve problems teacher has to be careful not to offer too much assistance because it will be at risk of making students to be overly dependent rather than independent. The classes lasted for 60 minutes for six weeks. The step for teaching the students using the Guided Method of Instruction are as follows:

Step 1: First, problem is posed to the students on the topic being taught. This facilitates the students' familiarity of the concepts.

Step 2: Next, students are allowed to think and solve the problem presented to them individually. This step allows students use their manipulative skills need for the concept being taught.

Step 3: Students discuss their answers to the questions with regard to the similarities and differences observed. This process encourages students to participate in the overall learning actively and gives room for constructive criticism.

Step 4: Students return to their home groups for interaction with other members. They take turns to teach other members what they have mastered from their respective expert sheets.

Step 5: Finally, students share their ideas and findings from their respective answers. This step helps students appreciate the views of their colleagues and facilitates good understanding and conclusion. These step are presented in a flow chart (figure 3.3).

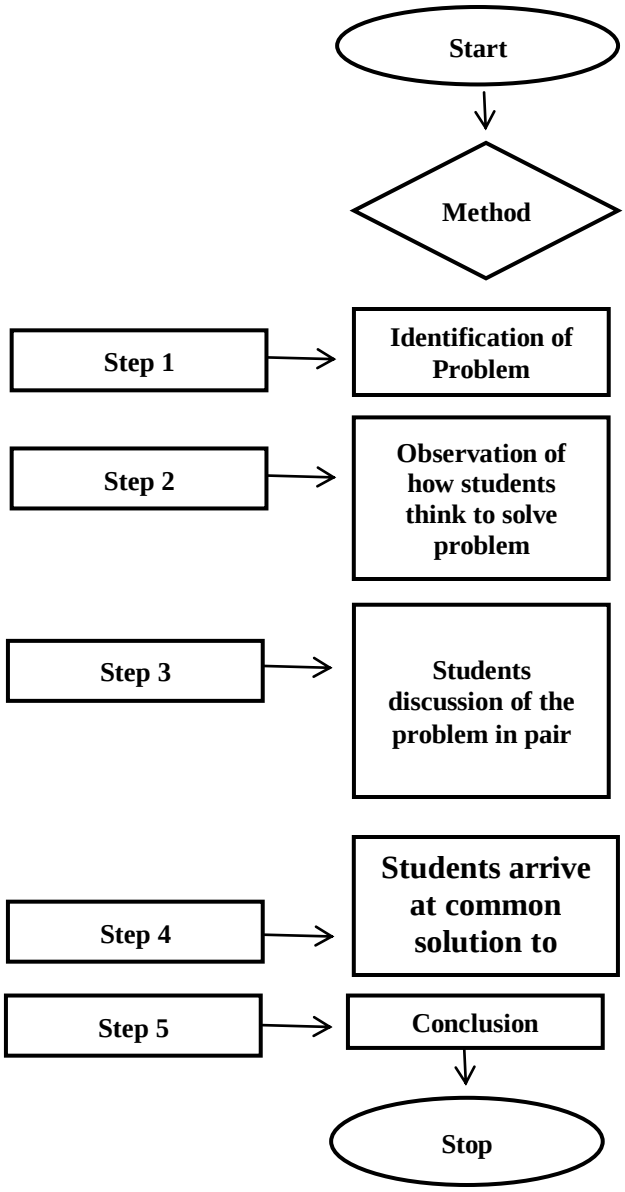


Figure 3.3: Flow Chart of Guided Discovery Method of Instruction
Source: Jensen & Finley (1996)

Appendix 5

Teaching the Control Group (Lecture Method of Instruction)

The students in the control group were taught the same concepts taught to students in the experimental groups 1 & 2 using the lecture method by the researcher and a trained research assistant who is a mathematics teacher in the school. The researcher ensures that the lesson plan designed for this purpose was strictly followed. The normal class time table for mathematics was used three times a week. The classes lasted for six weeks. The duration of each lesson was 60 minutes. Appendix presents the lesson plan used in teaching the control group.

Appendix 5

Jigsaw II Cooperative strategy lesson procedures

Experimental Group One

Expert Group 1: Lesson Two

Subject: Mathematics

Topic : Geometry

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

AverageAge: 17years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjective: By the end of the lesson, the student should be able to recall and describe properties of parallelograms rhombus and kites.

Previous Knowledge: the student have been tough the

Instructional Materials: Chalkboard instrument (ruler, protractor and set square)

Introduction: The teacher introduces the lesson by giving a little talk on properties of parallelogram, rhombus and kites. The other steps in Jigsaw ii follow this

Step 1: This has already been done: this is expert group 1

Step 2: This has already been done during lesson 1

Step 3: The group answer exercise 3b (NGM JS2, Pg.21-22)

Step 4: Quiz is giving from exercise 3b (NGM JS2,Pg. 21-22)

Step 5: Members return to their home group (HG) for interaction

Step 6: The whole class are quizzed based on lesson 2 from their various expert groups (Expert group 1-4).

Step 7: The teacher does a general review of the four lessons (lesson 1 from the four expert group).

Step 8: The teacher does this in the conclude week treatment.

Step 9: the teacher does this in the concluding week of treatment

Step 10: Conclusion is question and answer sessions

Expert Group 1: Lesson one

Subject: Mathematics

Topic: Geometry

Sub-topic: Quadrilaterals

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

Average Age: 12 years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson students should be able to identify and define parallelograms rhombuses and kites

Previous Knowledge: The students have been taught geometric figures like rectangles, squares, triangles and circles in their previous class.

Instructional Material: Chalk board instruments (ruler protractor and sets square)

Introduction: The teacher introduces the lesson by giving a little talk on the meaning of parallelograms, rhombuses and kites. The other steps in Kigsaw II.

Procedure follow this

Step 1: This has already been done: this is expert group 1

Step 2: The students are given their expert sheet which contains what they are expected to master;

i. Definition of parallelograms, rhombuses and kites

ii. Properties of parallelograms, rhombuses and kites

They are to use the text book New General Mathematics (NGM) for JS II pages 20 – 23

Step 3: The group answers exercise 3a (NGM JS 2, Pg. 20 – 21)

Step 4: Quiz is giving from exercise 3a (NGM SS 1 pages 20 – 21)

Step 5: Members return to their home group (HG) for interactions

Step 6: The whole class are quizzed based on lesson 1 from their various expert groups (Expert group 1 – 4)

Step 7: The teacher does a general review of the four lesson (lesson 1 from the four expert groups)

Step 8: The teacher does this in the concluding week of treatment.

Step 9: Teacher does this in the concluding week of treatment

Step 10: Conclusion is question and answer sessions

Expert Group 1: Lesson Three

Subject: Mathematics

Topic: Geometry

Sub-topic: Connections between quadrilaterals

Class Ability: Average

Average Age: 12 years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson, students should be able to relate quadrilaterals to the environment where necessary.

PreviousKnowledge: The students have been taught geometric figures like rectangles, square, triangles and circles in their previous class

InstructionalMaterials: Diagrams and definitions of common quadrilaterals

Introduction: The teacher introduces the lesson by giving a brief talk on the definition of common quadrilaterals. This other steps in the Jigsaw II procedure follow this

Step 1: This has already been done; this is expert group II

Step 2: The students are given their experts sheet which contains what they are expected to master;

i. Connections between quadrilaterals and the environment

ii. Relationship between quadrilaterals

They are to use the text book New General Mathematics (NGM) for JS 2 page 24

Step 3: The group answer exercise 3d, question 1 – 7, page 24 (NGM)

Step 4: Quiz is given from exercise 3d, question 1 – 7, pg. 24 of NGM

Step 5: Members return to their home group (HG) for interaction

Step 6: The whole class are quizzed based on lesson one from their various expert groups (expert group 1 – 4)

Step 7: The teacher does a general review of the four lessons (Lesson 1 from the four expert groups)

Step 8: The teacher does this in concluding week of treatment

Step 9: The teacher does this in concluding week of treatment

Step 10: Conclusion is question and answer session.

Expert Group 2: Lesson one

Subject: Mathematics

Topic: Geometry

Sub-topic: Relation between quadrilaterals

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

Average Age: 12 years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson students should be able to show how various quadrilaterals relate to each other.

PreviousKnowledge: The students have been taught how quadrilaterals relate to the environment where necessary.

InstructionalMaterials: Chalk board instrument (ruler, protractor and set square)

Introduction: The teacher introduces the lesson by giving a little talk on the relationship of various quadrilaterals to each other. The other steps in the Jigsaw II procedure follow this

Step 1: This has already been done, this is expert group II

Step 2: This has already been done, during lesson one.

Step 3: The group answers exercise 3d (NGM JS 2, question 8 – 10 pg. 25)

Step 4: Quiz is giving from exercise 3d (NGM JS 2, question 8 – 10 pg. 25)

Step 5: Members return to their home group (HG) for interaction

Step 6: The whole class are quizzed based on lesson II from their various expert groups (expert group 1 – 4)

Step 7: The teacher does a general review of the four lessons (lessons 2 from the four expert group).

Step 8: The teacher does this in the concluding week of treatment

Step 9: The teacher does this in the concluding week of treatment

Step 10: Conclusion is question and answer sessions

Expert Group III (Experimental Group): Lesson one

Subject: Mathematics

Topic: Geometry

Sub-topic: Angles between lines

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

AverageAge: 12 years

Sex: Male and Female

NumberinClass: 72

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson, the student should be able to identify, name and calculate angles meeting at a point and angles where a transversal crosses parallel lines

PreviousKnowledge: The students have been taught how to construct angles on a straight line in their previous class.

InstructionalMaterials: Some problems solved on a card board paper and chalk board instrument.

Introduction: The teacher introduces the lesson by giving a little talk on angles meeting at a point. The other steps of Jigsaw follow this

Step 1: This has already been done; this is expert group 3

Step 2: The students are given their expert sheet which contains what they are expected to master;

i. Angles between lines

ii. Angles in a triangle

They are to use the text book New General Mathematics (NGM) for JS 2 page 38 – 39

Step3: The group answer exercise 6a (NGM JS 2, pg. 39)

Step 4: Quiz is giving from exercise 6a (NGM JS 2, pg. 39)

Step 5: Members return to their Home Group (HG) for interactions

Step 6: The whole class are quizzed based on lesson 1 from their various expert groups (expert group 1 – 4)

Step 7: The teacher does a general review of the four lessons (lesson 1 from four expert groups)

Step 8: The teacher does this in the concluding week of treatment

Step 9: The teacher does in the concluding week of treatment

Step 10: Conclusion is question and answer sessions.

Jigsaw II Cooperative Strategy Lesson Procedures

Expert Group 2: Lesson two

Subject: Mathematics

Topic: Geometry

Sub-topic: Angles in a triangle

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

AverageAge: 12 years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson, the students should be able to calculate angles in a triangle.

PreviousKnowledge: The students have been taught how to calculate angles meeting at a point and where a transversal crosses parallel lines

InstructionalMaterials: Some problems clearly solved on a card board paper

Introduction: The teacher introduce the lesson by giving a brief talk on angles in a triangle. The other steps in the Jigsaw II procedure follow this

Step 1: This has already been done, this is expert group 3

Step 2: This has already been done during lesson one

Step 3: The group answer exercise 6b (NGM JS 2, pg. 40)

Step 4: Quiz is giving from exercise 6b (NGM JS 2, pg. 40)

Step 5: Members return to their Home Group (HG) for interactions

Step 6: The whole class are quizzed based on lesson 2 from their various expert groups (expert group 1 – 4)

Step 7: The teacher does a general review of the four lessons (lesson 2 from four expert groups)

Step 8: The teacher does this in the concluding week of treatment

Step 9: The teacher does this in the concluding week of treatment

Step 10: Conclusion is question and answer sessions

Expert Group 4: Lesson one

Subject: Mathematics

Topic: Geometry

Sub-topic: angles in a quadrilateral

Class: Junior Secondary year two (JSS)

ClassAbility: Average

AverageAge: 12 years

Sex: Male and Female

NumberinClass: 72

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson, students should be able to calculate angles in quadrilaterals

PreviousKnowledge: The students have been taught how to calculate the sizes of angles in triangles.

Introduction: The Teacher introduce the lesson by giving a brief talk on how to calculate angles in quadrilaterals. The other steps in Jigsaw II procedure follow this

Step 1: This has already been done, this is expert group 4

Step 2: The students are given their expert sheet which contains what they are expected to master;

i. Angles in a quadrilateral

ii. Angles in a polygon

They are to use the text book New General Mathematics (NGM) for JS 2, pg. 40 – 44

Step 3: The group answers exercise 6c (NGM JS 2, page 41 – 42)

Step 4: Quiz is giving from exercise 6c (NGM JSS2, pg. 41 – 42)

Step 5: Members return to their home group for interactions

Step 6: The whole class are quizzed based on lesson 1 from their various expert groups (expert group 1 – 4)

Step 7: The teacher does a general review of the four lessons (lesson 1 from the four expert groups)

Step 8: The teacher does this in the concluding week of treatment

Step 9: The teacher does this in the concluding week of treatment

Step 10: Conclusion is question and answer sessions

Expert Group 4: Lesson two

Subject: Mathematics

Topic: Geometry

Sub-topic: Angles in a polygon

Class: Junior Secondary School Two (JSS2)

ClassAbility: Average

AverageAge: 12 years

Sex: Male and Female

Duration: 60 minutes

BehaviouralObjectives: By the end of the lesson the student should be able to

i. Differentiate types of polygon

ii. Calculate sizes of interior angles of a polygon

PreviousKnowledge: The students have been taught how to calculate angles in a quadrilateral.

InstructionalMaterials: Polygon chart showing their names and number of sides

Introduction: The teacher introduces the lesson by giving a little talk on the instructional material. The other step in the Jigsaw II procedure follow this

Step 1: This has already been done, this is expert group 4

Step 2: This has already been done during lesson one

Step 3: The group answers exercise 6d (NGM JS 2, pg. 43 – 44)

Step 4: Quiz is giving from exercise 6d (NGM JS 2, pg. 43 – 44)

Step 5: Members return to their Home Group for interactions

Step 6: The whole class are quizzed based on lesson 2 from their various expert groups (expert 1 – 4)

Step 7: The teacher does a general review of the four lessons (lesson 2 from the four expert groups)

Step 8: The teacher does this in the concluding week of treatment

Step 9: The teacher does this in the concluding week of treatment

Step 10: Conclusion in question and answer session

Appendix 6

Expert Sheet

Expert Group 1

Expert Sheet: Quadrilaterals

Content

i. Definition of parallelograms, Rhombuses and Kites

ii. Properties of parallelograms, Rhombuses and kites

Expert Group 2

Expert Sheet: Quadrilaterals

Content

i. Connection between quadrilaterals and the environment

ii. Relationship between quadrilaterals

Expert Group 3

Expert Sheet: Angle in a polygon

Content

i. Angle between lines

ii. Angle in a triangle

Expert Group 4

Expert Sheet: Angle in a polygon

Content

i. Angle in a quadrilateral

ii. Angle in a polygon

Appendix 7

Guided Discovery

Lesson 1

Class: JS II

Duration: 60 minutes

Average Age: 12 years

Topic: Geometry

Sub-Topic: Quadrilaterals

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

i. Identify and define parallelograms, rhombuses and kites

ii. Recall and describe the properties of parallelograms, rhombuses and kites

Instructional Material: Chalk board instruments (ruler, protractor and set square) charts, cut materials

Instructional Procedure

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

Step II: use the chart to show how a parallelogram and a kite looks. A kite is a quadrilateral in which one diagonal is a line of symmetry. A parallelogram is a quadrilateral that has opposite sides parallel.

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

Evaluation

i. Write down three differences between a rhombus and a parallelogram

ii. Write down three differences between a kite and a rhombus.

Lesson 2

Class: JS 2

Duration: 60 minutes

Average Age: 12 years

Topic: Geometry

Sub-Topic: Connection and relationship between quadrilaterals

Objective: Students should be able to

i. Relate quadrilaterals to the environment where necessary

ii. Show how various quadrilaterals relates to each other.

Teaching Aids: Diagrams and definitions of common quadrilaterals on a chart

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 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 a 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 are to discover the following connections

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

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

iii. All rhombuses are kites

iv. All squares are kites, not rhombus

v. But all kites are not rhombuses

Evaluation

1. The diagonal of kite cross at right angles. Name other shapes for which this is true

2. Write down four shapes which are special example of trapezium

Lesson 3

Class: Junior Secondary School Two (JSS2)

Duration: 60 Minutes

Average Age:

Topic: Geometry

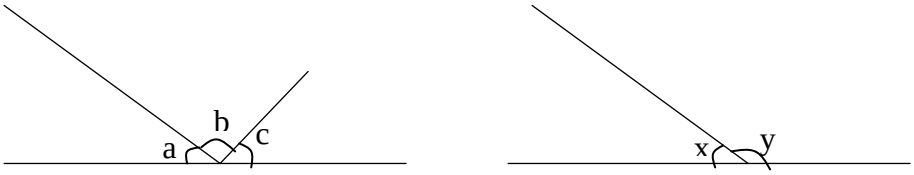
Sub-Topic: Angles between lines

Objective: Students should be able to identify name and calculate the sizes of angles where a transversal crosses parallel lines and where angles meet at a point

Teaching Aid: Chalk board instruments and some problems solved on a cardboard paper

Procedure:

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



ii. Add up the total. This will establish angles on a straight line equals 180^0

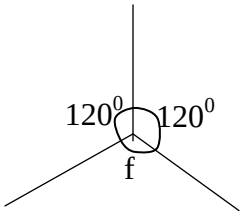
Step II: Do the same to establish vertically opposite angles are equal



Step III: Draw two parallelograms 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;

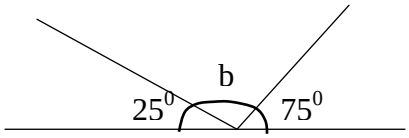


Vertically opposite angles are equal

Corresponding angles are equal

Alternating angles are equal

Thus find the values of the lettered angles



Solution

1. $25^0 + b + 75^0 = 180^0$ (angles on a straight line)

   $b + 100^0 = 180^0$

   $b = 180^0 - 100^0$

   $b = 80^0$

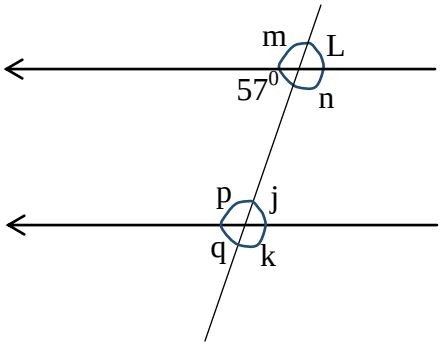
2. $f + 120^0 + 120^0 = 360^0$ (sum of angles at a point)

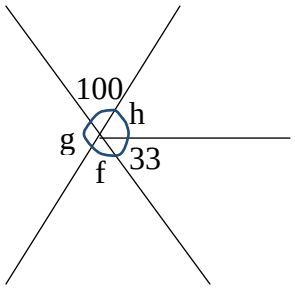
   $f + 240^0 = 360^0$

   $f = 360^0 - 240^0$

   $f = 120^0$

Evaluation: Find the sizes of the lettered angles





Lesson 4

Subject: Mathematics

Class: Junior Secondary School Two (JSS2)

Duration: 60 Minutes

Average Age: 12 years

Topic: Geometry

Sub-Topic: Angles in a triangle

Objective: Students should be able to

i. Differentiate between the kinds of triangles; isosceles, equilateral, scalene and right-angle triangles

ii. Calculate the sizes of angles in a triangle

Teaching Aid: set square, ruler, protractor and board. Also some problems solved on a cardboard paper.

Procedure:

Step 1: Use the ruler and protractor to construct different kinds of triangles on the chalk board showing the differences.

Step II: Define the differences as;

i. Equilateral triangle has 3 sides and 3 angles equal. Each is 60^0

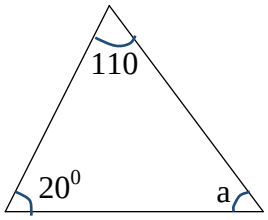
ii. Isosceles triangle is one which 2 sides and 2 angles are equal. The two equal sides have the base angles

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

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

Step III: Use the ideas of tearing off 3 angles of a triangle to show that the sum of angles of triangles is the same as that of angles on a straight line

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



Solution

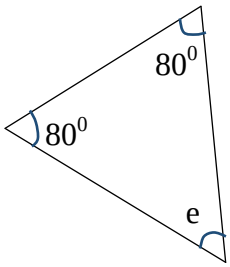
$a + 20^0 + 110^0 = 180^0$ (angles in a triangle)

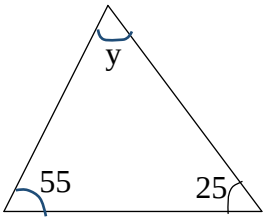
$a + 130^0 = 180^0$

$a = 180^0 - 130^0$

$a = 50^0$

Evaluation: Find the sizes of the lettered angles





Lesson 5

Subject: Mathematics

Class: Junior Secondary School Two (JSS2)

Duration: 60 Minutes

Average Age: 12 years

Topic: Angles in quadrilateral

Objective: Student should be able to calculate the sizes of angles in a quadrilateral

Teaching Aid: Protractor, sketches on the chalkboard

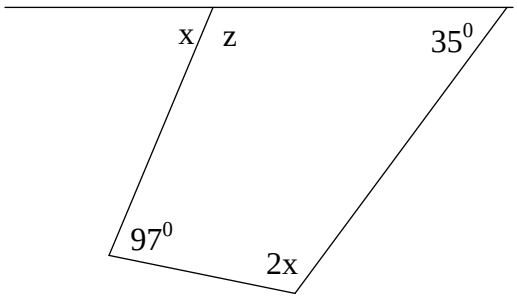
Procedure:

Step I: Use the idea of dividing any quadrilateral into 2 triangles by drawing it's 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 in a quadrilateral 1s 360^0

Step IV: Find x in the figure, hence the other two angles in the figure



Solution

$Z = 180^0 - x$ (angle on a straight line)

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

$x + 312^0 = 360^0$

$x = 360^0 - 312^0$

$x = 48^0$

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

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

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

Evaluation: Calculate the 4^{th} angles of the quadrilaterals whose other 3 angles are

i. $100^0, 60^0, 80^0$ (ii) $109^0, 71^0, 85^0$, (iii) $58^0, 117^0, 122^0$

Lesson 6

Subject:Mathematics

Class: Junior Secondary School Two (JSS2)

Duration: 60 Minutes

Average Age: 12 years

Topic: Geometry

Sub-Topic: Polygons

Objective: Students should be able to;

i. Differentiate types of polygon

ii. Calculate sizes of interior angles of a polygon

Teaching Aid: Polygon chart showing their names and number of sides

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 on the teaching aid

Step III: Use the idea of joining one vertex 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 angles of an n sided polygon = $(n - 2) \times 180^0$

Step IV: The sum of seven of the angles of a decagon is 1170^0. The other three angles of the decagon are all equal to each other. Calculate the size of the other 3 angles.

Solution

A decagon has 10 angles and 10 sides

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

$S = (10 - 2) \times 180^0$

$S = 8 \times 180^0$

$S = 1440^0$

Sum of 7 angles = 1170^0

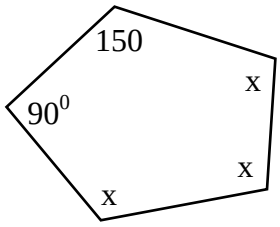
Sum of the other three angles = $1440^0 - 1170^0$

= 270^0

Size of each angle = $270^0/3 = 135^0$

Step V: Give another example as follows;

Find the value of x in the polygon below



Solution

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

= $(5 – 2) \times 180^0$

= 3×180^0

= 540^0

$90^0 + 150^0 + x + x + x = 540^0$

$240^0 + 3x = 540^0$

$3x = 540^0 - 240^0$

$3x = 300^0$

$3x/3 = 300^0/3$

$x = 100^0$

Evaluation

1. Calculate the size of each angle of a regular

i. Hexagon

ii. Decagon

2. The sum of angles of a regular polygon is 1980. How many sides has the polygon?

Appendix 8

Lecture Lesson Plans

Lesson One

Subject	Mathematics
Topic	Geometry
Sub-topic	Quadrilaterals
Class	Junior Secondary School Two (JSS2)
Class ability	Average
Average age	12 years
Sex	Male and Female
Duration	60 minutes
Teaching Aid	Chalk board instruments (ruler, protractor and set square)
Behavioural Objective	By the end of the lesson students should be able to i. Identify and define parallelograms, rhombuses and kites ii. Recall and describe the properties of parallelograms, rhombuses and kites
Previous Knowledge	The students have been taught geometric figures like rectangles, squares, triangles and circles in their previous class
Introduction	The teacher introduce the lesson by asking the students questions based on their previous knowledge. For example, what is a triangle? Mention two everyday objects that have a rectangular shape etc.
Presentation	The teacher presents the lesson through the following steps
Step I	Teacher define quadrilaterals and give example while students listen attentively
Step II	The teacher define parallelograms, rhombuses and kites, for example A parallelogram is a quadrilateral with opposite sides parallel.
Step III	The teacher uses the teaching aid to draw the quadrilaterals
Step IV	From the drawing teacher explain the properties of parallelograms rhombuses and kites.
Evaluation	The teacher evaluates the lesson by asking the students questions based on the new topic. For example; 1. Write down three differences between a rhombus and a parallelogram

	2. Write down three differences between a kite and a rhombus.
Conclusion	The teacher concludes the lesson by giving students notes to copy on the new lesson.
Assignment	1. Draw a parallelogram of side 5cm 2. Make a rhombus from a sheet of paper

Lesson Two

Subject	Mathematics
Topic	Geometry
Sub-topic	Connection and relationship between quadrilateral
Class	Junior Secondary School Two (JSS2)
Class ability	Average
Average age	12 years
Sex	Male and Female
Duration	60 minutes
Teaching Aid	Diagrams and definition of common quadrilaterals
Behavioural Objective	By the end of the lesson, students should be able to i. Relate quadrilaterals to the environment where necessary ii. Show how various quadrilaterals relate to each other.
Previous Knowledge	The students have been taught the definitions and properties of quadrilaterals (parallelograms, rhombuses and kites)
Introduction	The teacher introduces the lesson by asking the students questions based on the new lesson. For example; is a rhombus the same as a kite? Why?
Presentation	The teacher presents the lesson through the following steps
Step I	The teacher use the teaching aid to help students see the connection between quadrilaterals (parallelograms, rhombuses and kites)
Step II	Teacher explain the relationship between a parallelogram and a rhombus in terms of the similarity in their properties
Step III	The teacher explains the relationship between a rhombus and a kite using their properties
Evaluation	The students answer some questions given to them by the teacher as classwork in their mathematics exercise books. For example i. The diagonal of a kite cross at right angles, name other shapes for which

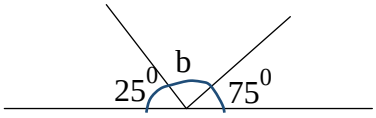
this is true.

2. Write down four shapes which are special example of trapeziums etc.

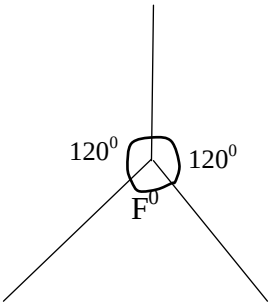
Conclusion The teacher concludes the lesson by marking and making correction of the class work. Teacher also give the students an assignment, for example write true of false

1. All parallelogram are trapeziums
2. all squares are kites
3. Some kites are rhombuses

Lesson Three

Subject	Mathematics
Topic	Geometry
Sub-topic	Angles between lines
Class	JSS 2
Class ability	Average
Average age	12 years
Sex	Mixed
Duration	60 minutes
Teaching Aid	Some problems solved on a card board paper and chalkboard instrument
Behavioural Objective	By the end of the successful delivery of the lesson, the students should be able to identify, name and calculate angles meeting at a point and angles where a transversal crosses parallel lines
Previous Knowledge	The students can construct angles on a straight line
Introduction	The teacher introduces the lesson by asking the students to construct angles 108^o in their mathematics exercise books
Presentation	The teacher presents the lesson through the following steps
Step I	The teacher explains properties of angles meeting at a point such as sum of angles on a straight line is equal to 180^0, when transversal crosses parallel lines, the corresponding angles are equal etc.
Step II	The teacher display the teaching aid in the black board and clearly explain the solved problems to the students
Step III	The teacher further solves more problems on the board together with the students. For examples find the sizes of the lettered angles Solution  $25^0 + b + 75^0 = 180^0$ [sum of angles on a straight line] $b + 100^0 = 180^0$ $b = 180^0 - 100^0$ $b = 80^0$ etc.
Step IV	The teacher call up some students to solve some problems on the black board.

For example; find the size of angle F in the figure below



Solution

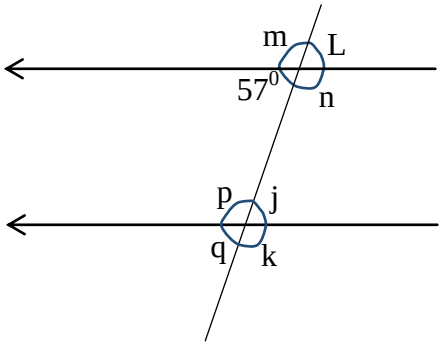
$F^0 + 120^0 + 120^0 = 360^0$ [sum of angles at a point]

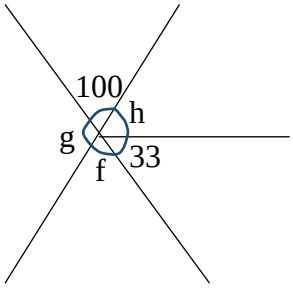
$F^0 + 240^0 = 360^0$

$F^0 = 360^0 - 240^0$

$F^0 = 120^0$ etc.

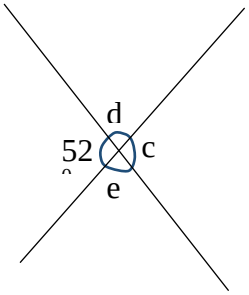
Evaluation Teacher evaluates the lesson by giving students some problems to solve in their mathematics exercise books as class work e.g. find the sizes of the lettered angles





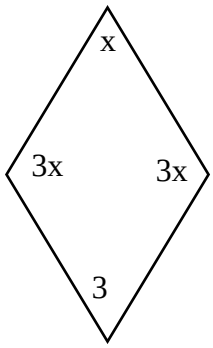
Conclusion Teacher concludes the lesson by marking the class work and make corrections.

Assignment Find the size of lettered angles



Lesson Six

Subject	Mathematics
Topic	Geometry
Sub-topic	Angles in a polygon
Class	Junior Secondary School Two (JSS2)
Class ability	Average
Average age	12 years
Sex	Male and Female
Duration	60 minutes
Teaching Aid	Polygon chart showing the names and of their number of sides
Behavioural Objective	By the end of the successful delivery of the lesson, the students should be able to i. differentiate types of polygon ii. calculate sizes of inferior angles of polygon
Previous Knowledge	The students have been taught how to find the lettered interior angles of quadrilaterals
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge for example; what is the value of x



Presentation	The teacher presents the lesson through the following steps
Step I	The teacher defines regular and non-regular polygons. Also the teacher display the polygon chart and explain.
Step II	The teacher derive the formulae for calculating the interior angles of polygons
Step III	The teacher and the students solve some problems as examples. The sum of

seven of the angles of a decagon is 1170^0. The other three are all equal to each other. Calculate the sizes of the other three angles.

Solution

A decagon has ten sides and ten angles use the formula

Sum of angles of polygon = $(n - 2) \times 180^0$

In a decagon n = 10

Sum of angles = $(10 - 2) \times 180^0$

$= 8 \times 180^0$

$= 1440^0$

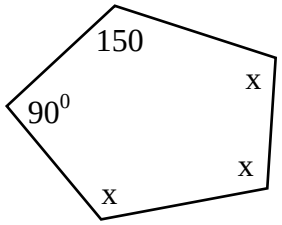
Sum of the seven angles = $1{,}170^0$

Sum of the other three angles = $1440^0 - 1170^0$

$= 270^0$

Size of each angle = $270^0/3 = 135^0$

Step IV Teacher call up a student to solve a problem on the board. For example; first find the value of x, then find the unknown angles in the polygon



Solution

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

$= (5 - 2) \times 180^0$

$= 3 \times 180^0$

$= 540^0$

$90^0 + 150^0 + x + x + x = 540^0$

$90^0 + 150^0 + 3x = 540^0$

$3x = 540^0$

$3x/3 = 540^0/3$

$x = 180^0$

Evaluation 1. calculate the size of each angle of a regular

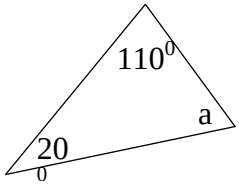
i. hexagon

ii. decagon

	2. the sum of angles of a regular polygon is 1980. How many sides has the polygon
Conclusion	Teacher concludes the lesson by marking the class work and making corrections.
Assignment	How many sides has a polygon, if the sum of its angles is 44 right angles?

Lesson Four

Subject	Mathematics
Topic	Geometry
Sub-topic	Angles in a triangles
Class	JSS 2
Class ability	Average
Average age	12 years
Sex	Male and Female
Duration	60 Minutes
Teaching Aid	Some problems clearly solved on a cardboard paper, set square, ruler, protractor and board
Behavioural Objective	By the end of the successful delivery of the lesson, the students should be able to: 1. differentiate between kinds of triangles; isosceles, equilateral etc. 2. calculate angles in a triangle.
Previous Knowledge	The students have been taught properties of plane shapes such as triangle, squares etc.
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge for example; mention three properties of a triangle etc.
Presentation	The teacher presents the lesson through the following steps
Step I	The teacher define the types of triangles (isosceles and equilateral triangle etc.). The teacher also prove that the sum of angles in a quadrilateral is equal to 360^0
Step II	The teacher explains the problems solved on the card board paper while students listen and pay attention.
Step III	The teacher solve more problems on the black board e.g. find the sizes of the lettered angles. Give reasons



Solution

$a + 20^0 + 110^0 = 180^0$ (sum of angles of a triangle)

$a + 130^0 = 180^0$

$a = 180^0 - 130^0$

$a = 50^0$

Step IV The teacher call up a students to solve a problem on the board e.g. calculate the fourth angle of a quadrilateral whose other three angles, in order are 95^0, 85^0, 90^0

Solution

Let the fourth be x

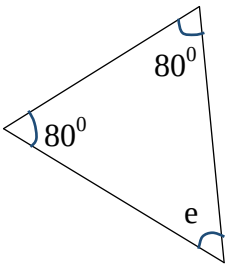
$95^0 + 85^0 + 90^0 + x = 360^0$

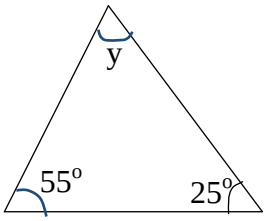
$260^0 + x = 360^0$

$X = 360^0 – 240$

$X = 100^0$

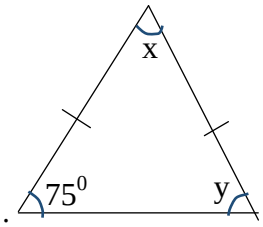
Evaluation The teacher give the students some exercise to solve as class work in their mathematics exercise book for example. Find the size of lettered angles. Give reasons





Conclusion The teacher concludes the lesson by marking the class work and making corrections.

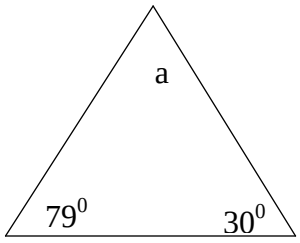
Assignment 1. Calculate the sizes of the lettered angles



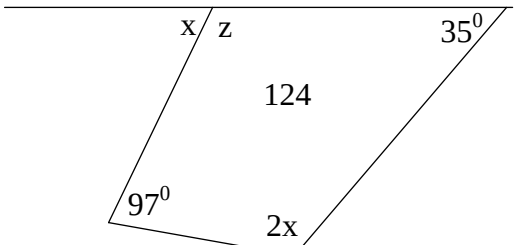
2. The angles of a triangle are x, 2x, and 3x in that order
a. With a question in x
b. Find x
c. Find the angles of the triangle

Lesson Five

Subject	Mathematics
Topic	Geometry
Sub-topic	Angles in a Quadrilaterals
Class	JSS II
Class ability	Average
Sex	Male and Female
Duration	60 Minutes
Teaching Aid	Protractor, sketches on the chalkboard
Behavioural Objective	By the end of the lesson, the students should be able to calculate sizes of angles in quadrilaterals.
Previous Knowledge	The students have been taught how to calculate the sizes of angles in triangle.
Introduction	The teacher introduces the lesson by asking the students questions based on their previous knowledge. For example; find the size of angle a



Presentation	The teacher presents the lesson through the following steps
Step I	Teacher sketch a quadrilateral, define it and show that the sum of angles in it is 360^0
Step II	The teacher solves a problem board as example e.g. find x in the other two angles



Solution

$Z = 180^0 - x$ (angle on a straight line)

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

$x + 312^0 = 360^0$

$x = 360^0 - 312^0$

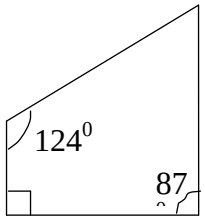
$x = 48^0$

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

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

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

Step III Teacher and the students solve more problems as example together. Find the sizes of the unknown angles.



Solution

Let the unknown angle be x

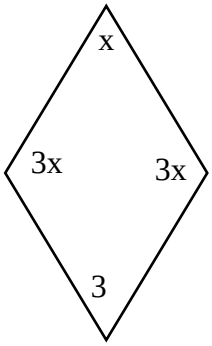
$x + 124^0 + 90^0 + 87^0 = 360^0$ (angles in a quadrilateral)

$x + 291^0 = 360^0$

$x = 360^0 - 291^0$

$x = 59^0$

Step IV The teacher call up a student to solve a problem on the board. What is the value of x in the diagram below.



Solution

$x + 3x + 3x + 3x = 360^0$ (angles in a quadrilateral)

$10x = 360^0$

$x = 360^0/10$

$x = 36^0$

Evaluation The teacher give the students some problem to solve as class work. Calculate the fourth angles of the quadrilaterals whose other 3 angles are;

i. 100^0, 60^0, 80^0

ii. 109^0, 71^0, 85^0,

iii. 58^0, 117^0, 122^0

Conclusion The teacher mark and making corrections.