EFFICACY OF LABORATORY INSTRUCTIONAL STRATEGY ON STUDENTS' GEOMETRY PERFORMANCE, RETENTION AND ATTITUDE AMONG JUNIOR SECONDARY SCHOOLS, OF KADUNA STATE, NIGERIA

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DECLARATION

I, Esther ALAKE MED/EDUC/41821/2012-2013 declare that this work entitled efficacy of laboratory instructional strategy on students' geometry performance, retention and attitude among junior secondary schools is written by me and a record of my own research work, confirmed by my major supervisors. The original work is mine except as specified in the acknowledgment and references; the work has not been presented in any previous application for the award of a degree.

_____ _____

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CERTIFICATION

This dissertation titled "Efficacy of Laboratory Instructional strategy on Students' Geometry Performance, Retention and Attitude among Junior Secondary Schools by Esther ALAKE meets the regulations governing the award of Master Degree in Mathematics Education of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to my husband Isaac Ola Alake and my children Olamide, Gbemisola and Omobadeji

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All the glory and honour to my GOD for making this work a reality. Many personalities in the field of academics whose efforts helped in the completion of this research deserve my special thanks. My profound gratitude go to my supervisors Dr.MammanMusa and Prof. C. Bolaji for their, constructive criticisms and valuable suggestions, I express my gratitude and expect God's reward.

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OPERATIONAL DEFINITIONS OF TERMS

Mathematics Laboratory: Is a method of teaching whereby students work in an informal manner, move around, discuss and choose their materials and method of attacking a problem, assignment or task. It is based on leaning by doing"

Mathematical Concept: A mental construct.

Instructional Strategies: Is set of unique activities which the teachers employ to implement a particular teaching method it is also a specific way of presenting instructional materials

Retention: The ability to store information which can be easily recalled from the short term memory and long term memory.

Performance: The overall measure of performance of students in a given test after a period of teaching.

Attitude: A psychological constructs theorized to be composed of emotional, cognitive and behavioural components.

Laboratory Instructional Strategy: Emperical learning through direct involvement of students**.**

Conventional Method: A traditional method of teaching which is teacher dominated (teacher centre)

LIST OF ABBREVIATIONS AND SYMBOLS

The following abbreviationswere used in this study

NERDC: National Educational Research and Development Council

NECO: National Examination Council

JSS: Junior Secondary School

WAEC: West African Examinations Council

WASSCE: West African Senior Secondary School Certificate Examination

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ABSTRACT

This study set out to investigate laboratory instructional strategy on geometry performanceretention and attitude in some selected secondary schools in Zaria, Kaduna State, Nigeria. A sample of N=290 students were drawn from 5,483 randomly selected from the secondary schools in Zaria Educational Zone. The subjects were divided into two groups, the experimental group N=150 and the control group N=140. The study adopted the pretest, posttest experimental and control group design. A pretest was administered before the treatment to establish group equivalence in ability. The subjects in the experimental group were then exposed to the treatment using mathematics laboratory instructional strategy, while the control group was exposed to the conventional method for a period of six weeks. Two instruments were developed and validated for data collection. They are (i) geometry Achievement Test (GAT), and (ii) Attitude Towards Geometry Inventory (ATGI)five null hypotheses were tested. The data collected were subjected to statistical analysis. The t-test for independent sample statistic was used to test for the hypotheses on performance.. Mann-Whitney u-test tool of least significant difference was used to test the attitude of the subjects to the laboratory instructional strategy. The major findings from the study were that; (i) students exposed to laboratory instructional strategy achieved,retained the learnt concept and developed more positive attitude to geometry than their counterpart exposed to conventional method of teaching (ii) The laboratory instructional strategy was suitable for both male and female students in teaching and learning of mathematics. On the basis of these findings recommendation were made some of these are as follows: mathematics teachers should be encouraged to use mathematics laboratory instructional strategy by providing all thematerials needed for effective implementation. Students' attitude towards mathematics should be positively changed by involving them to participate actively in the learning process.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Education is the totality of life experiences that people acquire and which enable them to cope with and derive satisfaction from living in the world. It is on this premise that it is believed that the quality of a nation's education is proportional to the level of its prosperity. Today, it is a reality to say that the standard of living of a nation is dependent on the level of science and technology of that nation. While science is the bedrock of technology, mathematics is the gate and key to sciences. According to Aguele(2005), the level of mathematics that determines the level of science and technology component of any nation. Mathematics has made inroads into every human pursuit. Mathematics is already the most important subject of learning for all. A conceptual understanding of mathematics has come to be a universal necessity for enlightened living. In Nigeria, emphasis is being placed on a minimum 'credit' in mathematics at WASSCE/NECO examination as prerequisite for admission to most of the Faculties and Departments in post secondary institutions in Nigeria.

Nwabueze(2010) says that for Nigerian secondary school students, mathematics is a nemesis. Yet it is a compulsory subject pursuant to any course of study in the university. ResearchersObioma(2005), Okereke(2006),

Agwagah(2007)had observed that students lack interest in the subject and perform poorly.

Esu (2006), attributed the students' poor performance in mathematics to factors such as the notion among students that mathematics is an abstract and difficult subject, inadequate qualified teachers to teach the subject as specialist, improper method of teaching mathematics, lack of mathematics laboratory, insufficient instructional aids and poor use of instructional materials. It is disheartening that research and data from National Examination Bodies like West African Examination Council (WAEC) have shown a consistent poor performance in this subject. Majority of secondary school students often dread and show negative attitude towards mathematics Awofala(2006) and the trends of their performance in the senior secondary school certificate examination is also a source of worry to the stakeholders. For instance, the percentage credit pass of students in May/June WAEC between 2008- 2013 is a concern as indicated on Table 1.1.

Table 1.1: - Students' Performancein May/June Senior Secondary School Examination (WAEC) 2008-2013.

YEAR	TOTAL NUMBER OF CANDIDATES	CREDIT A1-C6 (%)	PASS D7-E8 (%)	FAIL F9 (%)	ABSENT (%)
2008	1,019,524	33.97	28.16	34.47	3.4
2009	1,054,853	38.20	25.36	34.41	2.03
2010	1,149,277	41.12	28.16	34.47	3.4
2011	1,545,004	36.04	35.62	24.36	4.08
2012	1,249,028	46.75	26.75	24.24	2.26
2013	1,540,250	37.42	37.04	23.48	2.12

Sources: - Statistics Office WAEC, Kaduna (2013)

Though, there is a steady increase in the percentage of students with credit pass, the conclusion drawn from students' achievement in mathematics between 2008 and 2013 is that, more than 50% of students enrolled had below credit pass that is A1–C6. This is asource of worry to stakeholders. Poor academic achievement could be attributed to many factors among which teacher's strategy itself was considered as an important factor. The inadequacy of conventional teaching Models to improve students' retention , achievement and attitude has become a source of concern to many educators in Nigeria.

The WAEC Chief Examiner's Report (2005) suggested that student's performance in mathematics could be improved through meaningful and proper teaching. According to the report, teachers should help students develop interest in mathematics by reducing the abstractness of mathematics, and hence remove their apathy and fear of the subject. Several studies have shown other indices that could

affect students' mathematics achievement. Factors such as motivation and attitude have impacted students' achievement. Granville &Dika (2006), TYMMS (2005) investigated 21,000 students' attitude towards mathematics andsuggested that most important factors were the teacher and students' academic while age, gender and language were weakly associated with attitude. Schnabel (2005) studied gender differences in mathematics achievement, which favoured males. Attitudes are psychological constructs theorized to be composed of emotional cognitive, and behavioural components. Attitudes serve as functions including social expression, value expressive, utilitarian and defensive functions, for people who hold them Newbill(2005). It is generally believed that students attitude towards a subject determine their success in that subject.In other words, favourable attitude result to good achievement in a subject. Therefore, it is highly desirable that students do not only learn mathematics but develop favourable attitude toward the subject which in turn affect their performance.Another focus of this study is the performanceand retentionof the learnt mathematics concept. The laboratoryinstructional strategy is an effective strategy that could facilitate learning and enhance the retention of the learnt conceptYadar(2007).

Retention as the name impliesis the ability to retainand consequently remember things experienced orlearnt by an individualat later timeBichi (2005).When teaching is characterized by wrote learning,meaningless memorizing on verbalism, students make ineffective learning,and the facts thus learntare not

long retained,nor do they seem to have much effect in changing behaviorAyanmene and Anyachebelu (2009).However, when it is organized and meaningful,students apply principles, solve problem and interpret experimental datalearning become effective and the facts thus learnt are retained with the passage of time. In essence anything that affectshould improve retention while things that lead to confusionorinterferenceamong learnedmaterialsdecrease the speed and efficiency oflearning and accelerate forgetting.When a material is forgotten, it means it has not beenretained and hence can not be remembered at a later period.A conceptual understanding of mathematics has been a universal necessity for enlightened living; hence adequate teaching methods must be put in place for its teaching so that optimum achievement can be guaranteed. Mathematics laboratory is one of such methods of instruction used in teaching.

According to Andrew (2006) the mathematics laboratory means different thing to different teachers. To some it is a place where students use calculators or computer terminals to solve problems. To others it is a room that is a resource centre – a room for special activities such as tutoring students, working on project, playing games or writing make up tests. Some schools have a special room called a mathematics laboratory to which classes are brought for social enrichment lessons, but for some it is the normal classroom in which they teach their classes every day.

Mathematics laboratory is all about verifying and visualizing mathematical concepts in a fun way through educational aids Okigbo&Osuafor, (2008). When

related literature is being examined, it is seen that in developed countries like USA and East Algia Norwich even in India, laboratory instructional strategy has gone a long way enriching school mathematics at primary, secondary and tertiary institutions. India today is rated as the country with the highest collection of highly numerate skilled labour. This is a consequence of that country curriculum in which mathematics laboratory is the integral part of her regular curriculum. The mathematics students can construct a cylindrical shape for instance and handle it to study its shape and the components to convince themselves that the closed cylinder is nothing but the combination of a rectangle and two equal circles. Such student will readily recognize how the formula for the volume and surface areas of cylinder are derived, rather than cramming the formula. The use oflaboratory instructional strategy therefore helps create an enabling environment for effective learning of the subject.

In Nigeria, students are taught many mathematics facts, but rarely taught what the "mathematics process" is and how to employ it. The mathematics process is both a creative and explorative process and the most important face of mathematics. It is the fountain head from which mathematics knowledge flows and a central component of the infrastructure that makes today's technological and informational world possible. Teaching mathematics should deal with the process and not just confine to transferring the knowledge from the mind of the teachers to notebooks of students through the tip of a pen and for such a phenomena change in

teaching of mathematics, a right ambience is required and it is definitely the mathematics laboratory Manjunath (2008).

The present study is focusedon finding out whether or not the laboratory instructional strategy used as treatment has any efficacy on the learners.

1.2 Statement of the Problem

Many students in post-primary schools today show negative attitude towards the learning of mathematics. Nwabueze (2010)most students think that mathematics means 'getting the solution of a problem right or wrong'. When they get it wrong they think that they are not good enough in mathematics and loose interest in learning. The Society's believe about mathematics itself seem to drive away many students from liking the subject. The conventionalinstruction used all along had been found to be inadequate for effective teaching. According to Wolfe (2006); there are not enough instances when a teacher has tried to teach mathematics in an interesting way, say through activities and games.

Researchers Esu(2006),Manjunath (2008) had observed that lack of mathematics laboratory and mathematics teachers' non use of laboratory technique in teaching mathematics is one of the major factors that contribute to poor achievement in mathematics by secondary school students. The West African Examination Council (WAEC) chief examiner (2005, 2006, 2007, 2008, 2009, 2010, 2011& 2012) reported candidates lack of skill in answering almost all the questions asked in general mathematics. Evidence of poor performance in

mathematics by secondary school students point to the fact that the most desired technological, scientific and business application of mathematics cannot be sustained.

To this effect the study assessed the efficacy of laboratoryinstructional strategy in selected topics in mathematics. It alsoassessed the efficacy of this strategy on students understanding of these topics as were compared with those taughtusing the traditional strategy. In addition the efficacy of laboratoryinstructional strategyon students' retention and attitude was also determined. Any gender-related difference was alsosought for.

1.3 Objectives of the Study

The objectives of the study are as follows:

(1) assessethe efficacy of laboratory instructional strategy onperformance of students' in geometry at junior secondary schools.

(2) determinethe performance of male and female students taught geometry with laboratory instructional strategy.

(3) examinethe efficacy of laboratory instructional strategy on students'retention ability in geometry concept among JSS II students'.

(4) determinethe efficacy of laboratory instructional strategy on attitude change of male and female students' at the end of teaching the concept using laboratory instructional strategy.

(5) determinethe efficacy of laboratory instructional strategy on attitude change of students'exposed to laboratory instructional strategy.

1.4 Research Questions

This study soughtto answer the following questions:

1) Is there any difference in theperformanceof students taught using laboratory instructional strategy and those taught using theconventional Method?
2) Is there any difference in the performance of males and that of females at the end of instruction using laboratory instructional strategy?
3) Is there any difference in the retention level of JSS II students exposed to laboratory instructional strategy and thoseexposed toconventional method?
4) Is there any difference in attitude change between male and female students at the end of teaching the concept using laboratory instructional strategy?
5) Is there any difference in attitudechange betweenthe students taught geometry with laboratory instructional strategy and those taughtwith conventional method?

1.5 Research Hypotheses

Based on the research questions, five null hypotheses were formulated and tested at0.05 level of significance. The following null hypotheses were used for the study

HO_1: There is no significant difference between the mean performancescores of students taughtgeometry using laboratory instructional strategy and those taught using conventional method.

HO_2: There is no significant difference between the mean performancescores of male and female JS II students taught geometryusing laboratory instructional strategy.

HO_3: There is no significant difference in the mean retention scores of JSS II students exposed to mathematics laboratory instructional strategy and those exposed to conventional instruction.

HO_4: There is no significant difference between the attitude ofmaleand female JSS II students taught geometryusing laboratory instructional strategy.

HO_5: There is no significant difference between the attitude of JSS II students taught geometry with laboratory instructional strategy.

1.6 Significance of the Study

The study is useful in bringing the teaching of mathematics in line with modern technological devices and learning will take place effectively.

Laboratory instructional strategycan act like a concomitant between teachers and students and provide an opportunity to understand and discover the beauty, importance and relevance of mathematics as a discipline. This is helpful in showing the effectiveness and the usefulness of laboratory teaching strategy for teaching

mathematics to the teachers and all other classroom teaching and learning activities. The integrity of learning would be rekindled as meaningful learning will be achieved as students would have a strong background as how to manipulate manipulative materials for geometrical understanding.

Through the study, students' attitude in mathematics and performance can be improved. Policy makers and curriculum developers can see the needto emphasize the used of laboratory instructional strategy in mathematicsteaching in secondary schools. The study is also beneficial to mathematical organization such as Mathematical Association of Nigeria (MAN). The study is important to make secondary school students' remove some of the social apathy towards mathematics and learn that their achievement depends on their own active participation not only on their teachers. Thus, the students will appreciate the need for their involvement in mathematics activities in their classroom and help them to acquire both mathematics skills and mathematics knowledge which will enhance capacity building and sustainable development. In other words, the students will be enabled towards achievement of national goals for mathematics education.

It is hoped that the study will unravel the hidden mysteries of one of the oldest subject in human history by changing the society and students' believe enabling them to know that mathematics is fun and learners friendly.

The society will benefit from the study because if the study helps to improve student's performance and positive attitude in mathematics, then the subject and its

allied courses (engineering, pharmacy, industrial physics, etc.) will be studied by many students in institution of higher learning. If students study mathematics and its allied courses, our dream in the use of science and technology for capacity building and sustainable development will be fully realized.

It is also hope that students taught using laboratory instructional strategy will be more involved in the learning and as such will help them develop more confidence in themselves and what they learn, as the strategy encourages the interplay thought and actions. The student may become more alert and develop the ability to creative and reflective thinking so that on there own, they would try to correct there mistakes.

The findings of the study will provide on insight into the effects of variable like gender, attitude and retention improving learning among junior students in mathematics for mathematics educators and curriculum planners.

Finally, it is believed that the findings of this work will make a modest contribution to the existing body of knowledge and also be useful for further research.

1.7 Basic Assumptions

The following are the basic assumptions for the study.

1. The sample for the study is familiar with laboratory instructional strategy.
2. The sample for the study is familiar with the topic to be taught in this study.

The selected topics are appropriate for the level of the subjects used for the study.

1.8 Scope/Delimitationof the Study

The study examined the efficacy of laboratory instructional strategy on geometry performance, retention and attitude of Junior Secondary Two (JS 2) students in Zaria Educational Zone, Kaduna State. The research was limited to JSS2 students of some selected secondary schools in Zaria Educational Zone because Jss2 is a stable class, JSS1 are just coming for primary six (6) and Jss3 are preparing for Basic Education Certificate Examination

The study investigated one major unit in junior secondary school mathematics syllabus: Geometry

This unit is broken down in to topics as follows.

i. Area of parallelogram

ii. Angles

iii. Bearing and distance

iv. 3 dimensional figures

These topics were chosen because they form part of the basic foundations for learning any other geometrical concepts in secondary school mathematics. Also, WAEC Chief Examiners 2003-2012 identified these areas as difficult and students' lack of understanding of the concepts in their workings.

The study used two instruments which were developed by the researcher for data collection. These are:

1. Geometry achievement test (GAT) which is made up of40 structured multiple choice questions on the concept of geometry.
2. Attitude towards geometryinventory (ATGI) which is made of 20structured questionnaires.

The laboratory practical materials used in the study are geo-board, thread, model of clock on the cardboard papers,wooden compass graded from0^{o} to 360^{o}, angle disc astrolabe, tapes,cylinders made with cardboard papers and tins ofbournvita.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.01 Introduction

This chapter reviewed some researches conducted in mathematics education relevant to the study under investigation. The review was made on the efficacy of laboratory instructional strategy on students' geometry performance, retention and attitude among junior secondary school in Zaria Educational Zone.The literature review is organized under the following sub-headings:

2.02 Nature and Teaching of Mathematic in Junior Secondary School

2.03 Theoretical Framework

2.04 Concept of Mathematics Laboratory

2.05 Importance and Purpose of Mathematics Laboratory

2.06 Strategies for Teaching Mathematics

2.07 Mathematics Laboratory as a Teaching Techniques

2.08 Mathematics Laboratory and Academic performance

2.09 Performance and Retention of Students in Mathematics

2.10 Performance and Attitude of Students in Mathematics

2.11 Gender and Mathematicsperformance

2.12 Overview of Related Studies or Empirical Studies Reviewed

2.13 Implicationsof the Literature Reviewed

2.02 Nature and Teaching of Mathematics in Junior Secondary School

When properly viewed, mathematics is a model for thinking, developing scientific structure, drawing conclusions as well as solving problems (Odo, 2009)the above information stresses the fact that mathematics is not only a valuable subject but also a vital tool in science,technology and commerce, thus government in bothindustrialized and developing countries of the world in recognition of this role sought to provide greater opportunities for its study by their citizens and to make the teaching of mathematics more effective at every level of educationAkinsola&Popoola (2005)Manjunath (2008) has shownthat the teaching method use mostly in teaching of mathematics in our school is the traditional method with its attendant disadvantage, also teachers are not utilizing the laboratory method of instructionOkigbo and Osuafor(2008). Thus if students are to acquire basicconceptsof mathematics and essential scientific skills, there is need for teachers to employ the students activity based mode of teaching Yarda (2007). It is a known fact that, quality in teaching is directlyproportional to student's performance.However there are someinherent weaknesses in the teaching of mathematics at junior secondary school as outlined below:

3. Mathematics is taught as an abstract subject
4. Mathematics is taught as an isolated subject
5. Students are passive learner
6. Geometric and physical visualizations remain weak

Yarda (2007) acknowledge the fact that mathematics is better taught by "doing" in order to promote the development ofscientific interest and manipulative skill.Therefore mathematics teaching should be activity driven and students' actively engaged throughout the lesson.

This study focus on the use of laboratory instructional method to teach geometry in junior secondary mathematics.

2.03 Theoretical Framework

The study was guided by the learning theory based on the constructivist model. This learning theory indicated that mathematical understanding in young children is closely associated with sensory perception and concrete experience. Children begin to understand symbols and abstract concepts only after experiencing the ideas on a concrete level Dienes (1971).

The constructivity principles:- This principle states simply that "construction should always precede analysis". It is analogous to the assertion that children should be allowed to develop their concepts in a global intuitive manner emanating from their own experiences. According to Dienes, these experiences carefully selected by the teacher form the cornerstone upon which all mathematics learning is based.

The use of manipulatives is often assumed to be an integral part of the mathematics laboratory. Manipulatives are effective tools in mathematics education by helping student move from a concrete to an abstract level of understanding.

Student who see, touch, take part and manipulate physical object begin to develop clearer mental images and can represent abstract ideas more completely than those whose concrete experiences are limited (Heddens, 2006), student whose mathematical learning is firmly grounded in manipulative experiences will be more likely to bridge the gap between the world in which they live and the abstract world of mathematics Ball (2010).

Also, constructivism advances the idea that the individual begins to develop understanding through personal experiences and personal connections. "The interlacing of content, context and understanding, the individual negotiation of meaning, and the construction of knowledge" are promoted in a learning environment that promote constructivism Land &Hannafin (2006). Furthermore, collaboration, real or virtual, which brings about new ways of conceiving concepts that might not be visualized by individual alone are considered integral Abrami (2011). This study focused on the use of laboratory instructional strategy as supported byDienes to teach concept of and geometry in Junior Secondary School Mathematics.

2.04 Concept of Mathematics Laboratory

Education has for years been confronted with "new'' curricula, "new" programs, "new" techniques. Much of the newness" in education is a rejuvenation of past ideas. For example Manjunath (2008) in his dissertation, mathematics laboratory. An alternative teaching traced the concepts of mathematics laboratory to

1934 when A.R Hornbook wrote her book, laboratory method of teaching mathematics in secondary schools. Since that time mathematics laboratory have received periodic attention as a teaching technique. The current emphasis on mathematics laboratory is partially related to the trend in educational philosophy and psychology which provide active than persive learning, involvement in learning critical thinking, inquiry and relevancy. Mathematics laboratory have also receive the support of leading educators, for example Dienes and Biggs. Mathematics laboratory according to Andrew (2006) means different things to different teachers. The mathematics laboratory is a specially equipped room in a building where mathematics lessons or activities hold on regular basis or a corner of the regular classroom with tables and apparatus or room containing a collection of teaching aids for students' manipulation. The mathematics laboratory approach is a method of teaching whereby students work in an informal manner, move around, discuss and choose their materials and method of attacking a problem, assignment or task. It was reported that Aristotle said without image, thinking is impossible. As cited in Inekwe and Hassan (2006) asserted that enjoyment of nature and the world around us is a function of our perceptional skills and visual perception is the primary medium through which human beings come into contact with environment and 80% of our perception are visual.This study intends to investigate the efficacyof laboratory instructional strategyonperformance, retention and attitude in geometry at Junior Secondary School level.

2.05 The Importance and Purpose of Mathematics Laboratory

Oyedeji, 2008; Okigbo and Osuafor, 2008; Adeniran, 2006 studied the effect of mathematics laboratory and concluded that the experimental group had improved significantly in its performance compared with the control group. Etukudo and Utim (2006) strongly advocated mathematics laboratory since it has the following merits:

- It emphasizes understanding and meaning rather than manipulation skill;
- It demonstrates something in several different ways to heighten the learner's interest and deepen his insight;
- It encourages initiation and original thinking;
- It pays attention to a more precise vocabulary than was the case with the traditional mathematics;
- It leads the learners to discover rather than to tell him/her, the matter on hand;
- It generally utilizes the best results of up to date researcher.

Oyedeji (2008) suggested that the Mathematics Laboratory method is the best for the secondary school students aspiring to become a mathematician or to proceed to the schools of technology.

Some of the advantages of using mathematics laboratory to Kurumeh and Eniayewu(2007) include:

- It makes mathematics learning very interesting, meaningful and exciting;
- It is a means of verifying a mathematical principle, law or theory;
- It can be used to illustrate basic principles, laws or rules and development of such principle, laws or rules;

- It is a means of practicing one or more skills like the ability to construct, measure, arrange, observe, classify and interpret data;
- It provides opportunity for students to learn how to use cutters, turners, drill bits, mathematical set, paint, brush models of solids and charts and other kinds of equipments in mathematics;
- It encourages mathematical exploration and manipulation by students and keeps them alive and thinking which also help them to realize the application of mathematics.

Stone (2005) said that learning by experiences through experimental observations form a secure basis of gaining new knowledge. Students develop insight into the nature of a new idea or process and also gain idea because of active participation of individual student in the experimentation.

Mathematics is concerned with problem solving (Sinha, 2005). Also it is concerned with research for new ideas, new used of mathematics that needs imagination, intuition and reasoning to solve problems even more puzzling and difficult problem for such problems an experimental method or laboratory method can be used so that learner can lay hands and think of various methods to arrive at the solution which he/she cannot forget.

Ogunkunle (2009) itemized the advantages of using mathematics laboratory Instructional Strategy which include:

- Display mathematical information;

- Avenue for experimentation, through practical work;
- Pool of storage of mathematical materials for easy access;
- Removing abstractness and increasing effective teaching and learning.

Olatunde (2010) observed that the problem of ineffective teaching can be tackled through plan and intelligent application of the mathematics laboratory. Thus, Olatunde recommended the use of laboratory approach to the study of mathematics.

Yadar (2007) opined that no course in science and mathematics can be considered as complete without including some practical work. Practical work is even more important because of the fact that we learn by doing. Scientific practices and applications thus are rendered more meaningful. It is an established truth that an object handled impresses itself more firmly on the mind than the object merely seen from a distance or in an illustration. Thus practical work forms an important feature in mathematic course (UNESCO, 2008). "The scientific method with the use audiovisual aids adds variety to the method of teaching by giving depth and breadth which makes the learning process pleasant and meaningful" Adeniran (2006).

Bahasu, Bramanian and Sinha (2005) listed some importance of mathematics laboratory:

- It provides an opportunity to students to understand and internalize the basic mathematical concepts through concrete object and situations.

- It enables the students to verify or discover several geometrical properties and facts by using models or by paper cutting and folding techniques.
- It helps the students to build interest and confidence in learning the subject.
- The laboratory provides opportunity to exhibit the relatedness of mathematical concepts with everyday life.
- It provides greater scope for individual participation in the process of learning and becoming autonomous learners.
- It provides scope for greater involvement of both the mind and the hand which facilitate cognition.
- The laboratory allows and encourages the students to think, discuss with each other and the teacher. Thus assimilate the concept in a more effective manner.
- It enables the teacher to demonstrate, explain and reinforce abstract mathematics ideas by using concrete objects, models, charts graph picture, posters.
- The process of mathematics is emphasized much more than the product of mathematics.
- The laboratory approach boosts the creativity and scientific development of the brain of the students and satisfies their zeal to do something new and unique.

Katheryn (2005), outlined the purpose of Mathematics Laboratory instructional strategy as follows:

a) To develop physical involvement in order to add new ideas to their cognitive structure.
b) To provide readily accessible rich manipulative materials.
c) To make students experience with real world embodiment of mathematical ideas.
d) To emphasize on learning by doing.
e) To provide students with opportunities to discover and understand mathematical concept through their active involvement in solving problem.
f) To make students to think, to look for patterns and ask questions.
g) To develop an attitude of inquiry.
h) To aid students in developing their mathematical abilities and increase each students' understanding.

The purpose of mathematics laboratory method is to develop the much needed confidence in students, to generate interest and positive attitude towards mathematics and to make the students divergent thinkers.Hence themajorpurposeofthis study is to investigate the efficacy oflaboratory instructional strategy on students'geometry performance, retention and attitude at junior secondary school.

2.06 Strategies for Teaching Mathematics

Every teaching involves a strategy. A strategy (techniques used in teaching and thinking) may be used for one lesson or more. Strategies can be seen as sequences of moves frequently used in teaching of concepts Nnaji (2003) in Nnaji (2007). However, Opolot-Okurot(2005) saw strategies as approaches of averting aversion in teaching of school mathematics. These strategies can be changed, modified or continued as a lesson proceeds and the teacher interprets the feedback from the students. According to Ikpeazota (2005) there are up to 20 strategies developed for teaching and learning but only eight (8) of them are fit for teaching and learning of mathematics.

A teaching technique is set of unique activities which the teacher employs to implement a particular teaching method Orialfo (2003). It is also a specific way of presenting instructional materials. Different techniques may be employed within the same method and they are classified according to the nature of the teaching-whether on the verbal level or doing (activities) level, and according to the extent of students' participation. Both teaching techniques and teaching strategies are embedded in the teaching methods. According to Orialfo, teaching method includes any strategy or technique employed by a teacher while transmitting knowledge, skills, etc to students to ensure proper understanding of the lesson. A great deal of researches has been conducted regarding the effective method for teaching

mathematics. Awodeji (2005) studied the use of constructivist approach to teaching relationship between volume and capacity in school mathematics. The study was carried out using 14 in-service primary school teachers in the department of early Childhood and primary education. One of his major findings was that in-service teachers achieved significantly in mathematics topic. Aminu (2008) compared the effectiveness, suitability and productivity of lecture method and game method of teaching and learning of Lowest Common Multiple (LCM) of numbers in overcrowded junior secondary classes. Game method was found to be significantly more effective suitable and productive than lecture method.

The abstract nature of mathematics should be reduced through demonstration and practical methods. Okigbo&Osuafor (2008) investigated the effects of using mathematics laboratory in teaching on students' achievement in Junior Secondary (JS) school mathematics. The study was a quasi-experimental research in which a total of 100 JS3 mathematics students were involved. From the findings, it was observed that: the use of mathematics laboratory enhanced achievement in mathematics.

Kurumeh&Eniayeju (2008) investigated the use of 'Cuisenaire rods' approach to teaching of fractions in senior secondary schools. According to Kurumeh&Eniayewu (2008), the use of these rods in teaching mathematics topics is a type of manipulative approach that sparked the interests of mathematics students.

They found that the use of Cuisenaire rods removed the fear and problems which students used to express when they hear the word ‘fraction’.

For students to understand the concept of fraction Iji (2008) recommended the use of descriptive approach. Cox (2007) and Iji (2008) point to the same fact that, for students to understand fraction, there must be a deliberate and conscious effort on the part of the students. In a more recent study, Anyamene&Anyachebelu (2009) investigated the effect of the use of advance organizers on students’ achievement and retention in mathematics. The data collected were analysed using t-test. One of their major findings was that advance organizers have facilitative effect on achievement and retention in mathematics. Kurumeh (2007) advocated for the use of Ethno-mathematics approach for teaching measuration and inequalities. Nnaji (2007) recommended the use of games and simulation in teaching mensuration and inequalities. Researchers Opolot-Okurot(2005),Ikpeazota (2006) have proved the use of Polya’s Problem Solving Strategy (PPSS) in teaching some concepts in mathematics very effective and successful.

Ado &Akinbobola (2009) examined the use of constructivist approach in teaching of simple interest in school mathematics. This approach encourageintuitive thinking in learners and reconstruction of the wrong conception about simple interest imparted to the child from the primary school. Also, Akuezuilo&Chineoke (2009) studied the effectiveness of prior knowledge of behavioral objectives and study question on female students’ mathematic achievement. Results obtained

revealed that the experimental group achieved significantly (P<0.05) higher than the control group. Analogical reasoning has long been believed to play a central role in mathematics learning and problem solving. Richland, Holyoak& Stigler (2007) investigated the use of analogy in eight grade (JS3) mathematics classrooms. Their major finding was that teachers typically maintain control of each analogy by producing the majority of the comparison, though students are regularly involved in the components of the analogy that require minimal analogical thinking.

Etukudo&Utin (2006) investigated the effect of laboratory and discussion method on students performance in mathematics at the secondary level. Their findings revealed that; student who were taught mathematics with laboratory method significantly (P<0.05) performed better than those students who were taught with discussion method; those students who study mathematics with laboratory learning technique showed more interest than those who used discussion based learning strategy. Olatunde (2010) advocated for the use of mathematics laboratory instructional strategy for teaching mathematics. He recommended this approach because it enabled the students to verify and discover several geometrical properties using models paper cutting and folding techniques. The abstract nature of mathematics should be reduced through demonstration and practical methods. Okigbo and Osuafor (2008) investigated the effects of using mathematics laboratory in teaching on students' achievement in Junior Secondary (JS) School mathematics. The study was a quasi-experimental research in which a total of 100 JS3

mathematics students were involved. From the findings, it was observed that: the use of mathematics laboratory enhanced achievement in mathematics.

Manjunath (2008); observed that apart from being a specific subject, mathematics should be treated as a concomitant to any subject involving analysis and reasoning. Mathematics is presented as a purely deductive science though it is as much an experimental science as physics or biology. The students enjoy mathematics rather than turning into phobic, this gives all the freedom to a student to use the 3 dimensional mathematics model to explore, experiment and understand mathematics concepts through activities. They don't just learn but experience how a formula is derived by physically manipulating the learning materials.

Oyedeji (2010) discovered that students taught with laboratory instructional strategy performed significantly better than control group in geometry.

2.07 Mathematics Laboratory as a Teaching Technique at Junior Secondary School

A teaching technique is a set of uniqueactivitieswhich the teacher employs to implement a particular teaching methodOrialfo (2008). It is also a specific way of presenting instructional materials. Andrew (2006) defined teaching as an invigorating adventure, especially when students get excited about learning mathematics. This is why several researchers are enthusiastic about mathematics laboratory for mathematics students. Ojose (2008) said that empirical learning through the direct involvement of students arouses their interest and helps to sustain

attention. Activities and games make the process of learning more interesting and effective; (Marwana, 2009).

In introducing any new concepts, Ball (2010) said that mathematics experience should begin at the concrete levels; therefore the textbook should not be used during introductory work on new concepts. She said man thinks in terms of tangible or visual representations, sketches; and models. He used those devices to solve a problem, discover a new idea, or create a new product, and representation link thought processes and reality for instance the teaching/learning of longitudes and latitude in mathematics can be accompanied by improvising a metallic or plastic globe and using it in locating the position of an object along the equator. This concrete activity clarifies the concept of finding the longitude and latitude.

Heddens (2006) said, the role of experience in concept formation by the students is most important. And most often, the provision of concrete materials gives the students that experience that enables them to form ideas. And when they lack such concrete materials, their comprehension is greatly hindered.

Hassan (2006) had earlier recommended the use of laboratory strategy in teaching mathematics because it leads the students to formation of concepts out of experiences with discrete objects. In this case, the vague theories and imaginary objects take real shape and the students understand and perform better. The method of drill and verbal recitation makes learning boring and lacks motivation for further

learning, it is important therefore to improve the performance, with the view of considering their effect on teaching and learning of mathematics.

Adeniran (2006) stated that mathematics laboratory gives a new approach to mathematics learning because it provides a non threatening, realistic and concrete approach to learning of mathematics as opposed to the difficulty encountered in learning the formal abstract treatment of the typical textbook.

"As a rule, students readily become interested in things which are new and exciting, in things for which they can perceive practical values of applications to situations and fields of study in which they are already interested, and in things which involve puzzle elements of mystery" (Agina-Obu, 2005:19).

The use of models in reducing abstract nature of mathematics can better be expressed by this assertion given by Garu (2005) that "modern man makes extensive use of models to clarify his thoughts". Models are used to make students think and discover mathematical ideas and to stimulate their intellectual curiosity. They give reality and concrete representation to abstract ideas and facilitate creative thinking. They motivate the students and provide a means of making independent investigations by the students on the concept being taught in the class and also enhance retention.

Adebanjo (2005) reported the view of Abimbade (1997) that laboratory strategy in teaching and learning mathematics make students to learn more and retain better what they have been taught and that it also promote and sustain

students' interest. It allows the learner to discover themselves and their abilities. Agina-Obu(2005) said that mathematics laboratory instructional strategy enrich learners' knowledge and reinforce verbal instruction.

Recent emphasis on teaching-learning method is on that in which learners are made to have active participation. Active participation of learners will ease motivation and also minimize abstraction associated with mathematics learning, thus increasing learning experience. This can be facilitated by making use of laboratory instructional strategy which can minimize abstraction associated with mathematics.

Yadar(2007) posited that students learn best if they are given opportunity to see and to make observation of what they are taught.Laboratory instructional strategy provides students with opportunity to use their senses so that at the end of instruction, students can perform the teachers' stated objectives. These resources whether they are real or representation make the learning content meaningful, preserve and extend knowledge to unlimited number of mathematics learners.

2.08 Mathematics Laboratory and Academic Performance

A number of instructional strategies have been successfully used to improve students' achievement in mathematics.Adeniran (2006) stated that laboratory instructional strategy gives a new approach to mathematics learning because it provides a non-threatening, realistic and concrete approach to learning of mathematics as opposed to the difficulty encountered in learning the formal abstract

treatment of the typical textbook. Kurumeh(2007) said that empirical learning through direct involvement of students arouses their interest and helps to sustain attention. Activities and games make the process of learning more interesting and effective laboratory instructional strategy aids this effort (Wolfe, 2006).

2.09 Performance and Attitude of Students in Mathematics

Definitions of attitude towards mathematics are numerous as researchers and thinkers' conception, ideas and perspectives vary. According to a point of view, the attitude towards mathematics is just a positive or negative emotional disposition towards mathematics (Zan& Martino, 2007). Tapia (2005), considering attitudes towards mathematics from a multidimensional point define an individual's attitude towards mathematics as a more complex way by the emotions that he/she associates with mathematics, his/her beliefs towards mathematics which could be either positive or negative and how he/she behaves towards mathematics. Research on attitude in mathematics education has been motivated by the belief that 'something' called "attitude" play a crucial role in learning mathematics. A student's constant failure in mathematics can make him/her to believe that he/she can never do will in the mathematics thus successful experience can make him/her to develop positive attitude towards learning mathematics. This suggest that student's attitude towards mathematics could be enhanced through effective teaching strategies. It has been confirmed that effective teaching strategies can create positive attitude on the students towards mathematics. Akinsola&Olowojaiye (2008); Bolaji (2005); in a

study of the influence of students' attitude towards mathematics found that the teacher method of mathematics teaching and his personality accounted for the students' positive attitude towards mathematics.

Grows &Cebulla (2008) summarized research supporting the use of particular teaching strategies or methods. The results indicated an increased understanding of mathematical concepts, along with increased students achievement and attitudes. Javis and Pell (2007) contend that when students were taken to a science centre and given exposure to space science, the students' attitude towards mathematics was positively affected. Rule & Harrell (2006) observed the new method of analyzing mathematics attitudes through symbolic drawings, situated within the field of Jungian-Oriented analytical psychology which they applied to 52 pre-service elementary teachers before and after a mathematics methods course. Menal(2008) observed that students' poor performance in mathematics is as a result of their negative attitude and lack of interest in the subject.

2.10 Performance and Retention in Mathematics

Permanent and meaningful learningis the ultimate target ofour education endeavor. Understanding and retention are products of meaningful learning when teaching is effective and meaningful to the students, (Bichi, 2005).

Retention is the abilityto retain and consequently remember things experienced or learned by an individual at a time. It takes when learning is coded into memory. Thus, appropriate coding of incoming information provides the

indexthat may be consulted tothat retention takes place without an elaborate search in the memory lane (Bichi, 2005). The nature of the material to be codedcontributed to the levelof retention. Materials are relatedto the quality of retentionin terms of their meaningfulness, familiarity, concreteness and image evolvingcharacteristics (Okereke, 2006).

Severalfactors are known to influence retention. (Bichi, 2005) reports that learning should improve retention while things that leadto confusion or interference among learned materials decrease the speed and efficiency of learning and acceleratesforgetting. Retention level in relation to agehas been investigated by severalresearchers. Studieson retentionand instruction strategy have attracted the attention of many researchers in recent years. For instance, (Ezema and Dung, 2003)compared the effectiveness of concept mapping and guided discovery teachingstrategies on studentsretention of some chemistry concepts results showed a significant difference between theconcept mapping and guided discovery posttest scores in favour ofconcept mapping.it follows that theconcept mapping method enablesstudents to have better understanding of concepts taught and retain more knowledge of chemistryconcepts than the guided discovery method.

Ado and Akinobola (2009) compared the effectiveness of constructivist teaching method and the conventionalmethod with reference to achievement, retention and attitude. He found that students exposed to constructivistteaching method have higher cognitive achievement, more positive attitudes and higher

retention level than their counterparts taught using theconventionalteachingmethod. In this study, the retention level of student taughtprobabilityand geometryusing mathematical laboratory instructional strategy was investigated and compared with that of student taught same probability and geometry using conventional method.

2.11 Gender and MathematicsPerformance

Several issues regarding gender and mathematics remain controversial. Gender roll ideology is a significant factor in achievement process and also in terms of reward preference especially for girls. Researchers have shown that subjects are sex stereotyped, that mathematics, physical science and engineering are regarded as masculine subjects, while humanities, language and domestic subject are regarded as feminine. However, research evidence abounds to show that girls are not achieving well as expected in mathematics (Becker, 2005; Finn, 2008 & Erickson, 2009). Aiken (2007) reported that males are superior to females in mathematics. The evidence of the existence of gender gap in American secondary school mathematics was also attested by Glenn and Ashley (2009) who affirmed that there is a large gender gap that widens dramatically at percentiles above those that can be examined using standard data sources. They submitted that analysis of unobserved heterogeneity indicates that there is only moderate variation in the gender gap across schools and that the highest achieving girls in the U.S. are concentrated in a way small set of elite schools, suggesting that almost all girls with the ability to reach high mathematics achievement levels are not doing so. On the contrary Hyde

and Mertz (2009) reported that there is no gender gap among 99th percentile Asian Americans in Minnesota. However, Fryer and Levit (2009) noted that the gender gap in their result is very consistent across demographic groups and hence their basic conclusion is that there is variation in the gender gap across schools, but that the magnitude of variation is not very large. Okereke (2006) reported gender as significant factors in mathematics achievement. However, Okigbo and Osuafor (2008) reported gender as non significant when students are taught with tangram puzzle. Imoko&Agwagah (2006) examined the use of concept mapping technique for improving the students' interest in mathematics. The results revealed that concept mapping technique improved male and female students' interest in trigonometry equally. The international project for the evaluation of Educational Achievement (IEA) was conducted in twelve countries. The result of this project revealed that in all the countries, boys showed more interest in mathematics and had a higher performance in mathematics. Menal (2008) in his findings from Saudi, concluded that "boys perform better than girls in mathematics and boys have a more positive attitude than girls towards learning of mathematics.

Many studies have been carried out in the area of gender and attitude towards mathematics and most of the findings do agree that students with positive attitude towards mathematics have a higher chance of performing better in the subject than those with negative attitude. Generally, attitude affects learning and once a student has developed a kind of attitude not favourable to the subject, the

result will consequently affect the performance. Thus, there is a high correlation between attitude and performance. Ashcraft (2006) in her study of sex differences in attitude towards mathematics in secondary schools found that, there was statistically a high significant difference between the attitude towards mathematics for boys and girls. She concluded that "boys have more positive attitude towards mathematics than girls". Same idea was expressed by Sherman (2007) who concluded that gender differences in achievement could in part be attributed to the more favourable attitudes towards mathematics expressed by boys. The international project for the Evaluation of Educational Achievement (I.E.A) was conducted in twelve countries. The result of this project revealed that in all the countries, boys showed more interest in mathematics and had a higher performance in mathematics.

Kathryn (2009) confirmed that the result of the t-test (i.e. calculated value of t) indicated that American eight grade (JS2) students' attitudes towards mathematics study by gender had significant differences, the mean score for female students were statistically significantly higher with mathematics study than the mean scores reported for male students. Mathematics laboratory is a strategy that can foster confidence in mathematics in all students, arouse their interest, increase positive attitude and better achievement for both male and female students, thereby erase the issue of stereotyped.

2.12 An Overviewof Related Empirical Studies Reviewed

Available literatureindicates that many studies (Okigbo andOsuafor, 2008) and (Olatunde 2010) have been carried out to investigaterelative effects of different instructional strategies on students' achievement.

Etukudo and Utim, (2006) compare theeffectiveness of mathematics laboratory and discussion method on students performance in mathematics at the secondary level. Their findings, revealed that; students who were taught mathematics with laboratory method significantly ($P<0.05$) performed better than those who were taught with discussion method; those who study mathematics with laboratory teaching technique showedmore interest than those whoused discussion based learning strategy.

Similarly Okigbo and Osuafor (2008) investigated the effect of using mathematics laboratoryin teachingon students' achievement in junior secondary school mathematics. The study was a quasi-experimental research in which a total of 100JSS3 mathematics student were involved. From the findings, it wasobserved that;the use of mathematics laboratory enhanced achievement in mathematics.

This promptedthem to explain further that mathematics laboratory is a model of learning in which students learn not by receiving a message but interpreting it. This implies thatstudents must take some responsibility for their learning. This is because they are actively involved in teaching and learning process.The mathematics laboratory view of learning is rapidly gaining groundsand attracting

the attention of many researchers in mathematics education Andrew (2006) for instance Manjunath (2008) outlined theappropriate conception of teaching mathematics, a conception which isbased on mathematics laboratory and a model of learning as a conceptualchange. Manjunath (2008) carried out a research on students learning in mathematics laboratory way and reported that enjoy mathematics rather thanturning into phobic, this givesall the freedom to a student to use the 3 dimensional mathematics modelsto explore, experiment and understand mathematics concepts through activities. They don't just learn but experience how a formula is derived by physically manipulating thelearning materials.

In a similar investigation, Ogunkule (2009)comparedthe effectof mathematics laboratory instructional strategy and traditional teaching strategy on students' achievement and interest of mathematics concepts. The result of this study showed that the students taught using mathematics laboratory instructional strategy performed better than their counterparts exposed to traditional method.

In this study, two instructional strategies; namely the conventional method and themathematics laboratory instructionalstrategy was used to teach the concept ofgeometry toJSS II students. The efficacy oflaboratory instructional strategy on students' performance retention and attitude to geometry was theultimate goal.

2.13 Implicationsof Literature Reviewedto the Present Study

Several research reports in mathematics education at both elementary and secondary school levels have strengthened the viability and realityof laboratory instructional strategy view of learning in mathematics for instance recent research findings continuetocorroboratethe fact that the individuals construction of meaning is an active process of hypothesizing and hypothesis testing with theresultant effect that theindividualleanerisresponsible for his own learning (Land and Hannafin, 2006). This is what is motivating many mathematics educationresearchers to seek to redefine the role of classroom teacher in mathematics teaching and the need to deliberately allow the learnerto be actively involved in the teaching learning process (Manjunath, 2008).Dienes is continually implying that mathematicslearning is not spectator sport and, as such requires a very active type of physical and mental involvement on the part of the learners. Studies reported in the literatureshowed the effect of various teaching methods, strategies and techniques on achievement and attitude in mathematics. They include; constructivist approach, tangram puzzle game, laboratory approach, ethno mathematics approach and polya's problem solving strategy. Evidence abounds on the inevitability oflaboratory instructional strategy on mathematics learning outcomes. Alsothe conventional instruction which is only (chalk and talk) is inadequate for generating positive attitude and improvedstudents performance. Nworgu (2005) summarized a goods number of studies of sex differences and stated thatmajority of the studies found no sex

difference large enough to besignificant beyond .05 level.Even when significant sex differences werefound they neverfavour male orfemale for any given ability. To the best of the researchers'knowledge from available literature, it appears enough research has not been carriedouton theefficacyof laboratoryinstructional strategy in enhancing performance, retention and attitude of studentsin the mathematics classroom. Alsoeffect of genderon achievement and attitude of students when different strategies are used still has no conclusive end.To this effect, this study assessed the efficacy of laboratory instructional strategy on students' geometry performance, retention and attitude in junior secondary schools of Zaria Educational Zone, Kaduna State.

CHAPTER THREE

RESEACH METHODOLOGY

3.1 Introduction

The study examined the efficacy of laboratory instructional strategy on students' geometry performance, retention and attitude among junior secondary schools of Zaria Educational Zone. The focus of this chapter is on the methodology employed in carrying out the research design, population of the study, sample and sampling techniques, instrumentation, data collection procedures and analysis. The chapter is presented in the following format:

3.1.1 Research Design;

3.1.2 Population of the Study;

3.1.3 Sample and Sampling Techniques;

3.1.4 Instrumentation for Data Collection;

3.1.5 Validation of the Instrument;

3.1.6 Reliability of the Instruments;

3.1.7 Procedure forData Collection;

3.1.8 Data Analysis.

3.2 Research Design

The quasi-experimental designwas used for this study. The use of intact classes did not allow for randomization of the research subjects. Also the administrative set up in the schools is such that students are already organized in

classes and the administrators would not allow the classes to be disorganized for the purpose of the study. Thus, the specific design used for the study is pre-test, post-test control group design. The design is illustrated.

Two groups of students were used for data collection. The experimental (EG) and the control groups (CG). A pretest was administered to the two groups in order to determine the equivalence in ability of the two groups. In this design the experimental group was taught geometryusing laboratory instructionalstrategy. The control grouphad sixweekstreatment period, a posttest was administered to both groups of students to evaluate the effectiveness of the treatment. Thepost post-testwasadministered a week after the post-test to test for the students retention ability.

EG	O_1	X_1	O_2	O_3
CG	O_1	X_2	O_2	O_3

Figure 1: Source research design illustrate Sambo, (2008)

Where:

EG = Experimental Group

CG = Control Group

0_1 = Pretest

0_2 = Post-test

0_3= Post-posttest

X_1 = Experimental treatment (Laboratory Instructional Strategy)

X_2 = Conventional Method

The line implies involvement of intact groups.

3.3 Population of the Study

The population is made up of 5,483 Public Junior Secondary Two (JS2) mathematics students found in the 24 co-educational schools in Zaria Educational Zone, Kaduna State. The choice of JS2 mathematics students is based on the fact that geometry, formed part of the JS2 scheme of work for mathematics (NERDC, 2005). The total number of JS2 male and female student in public schools is 5,483 of which 2,234 are girls and 3,249 are boys. The details of the population are shown in Table 3.1.

Table 3.1: Population of the Study

			JSS II		
SN	**Name of Zone**	**No. of Schools**	**M**	**F**	**Total**
1.	Anchau	63	4627	1647	6274
2.	Birnin-Gwari	20	1268	1464	2732
3.	Giwa	33	2550	1312	3862
4.	Godogodo	36	1934	1511	3445
5.	Kachia	56	2106	1678	3784
6.	Kaduna	34	4123	4305	8428
7.	Kafanchan	49	2340	2012	4352
8.	Lere	43	3984	1969	5953
9.	Rigachikun	30	3086	1462	4548
10.	Sabon Tasha	65	5154	5772	10926
11.	Zaria	43	5657	3509	9166
12.	Zonkwa	46	1855	1585	3440
	Total	**518**	**38634**	**28132**	**66766**

Source: Kaduna State Educational Zone (2014)

3.4 Sample and Sampling Technique

The sampleselected in this study consist of two hundred and ninety (290) out of five thousand four eighty three (5,483) junior secondary year two (JS II)mathematics students drawn fromfour (4)out of twenty four (24) co-educational government owned secondary schools in Zariaeducational zone. The selectionof the two hundred and ninety study subject is in line with central limit theorywhich recommended thatthe minimum of thirty study subject is viable for experimentalstudy (Guidford,1965) simple random sampling (balloting with replacement) was used to select four co-educational school within Zaria educational zone this wasto minimize location of environmental differences (Afolabi, 2001).

From the first school selected one intactclasses were also chosen by simple random sampling(balloting with replacement) twointact classes wereassignedto experimental groups (laboratory instructional strategy and the remaining two intact classes conventional group (traditional teaching method). The selections of only co-educational school were purposive. This isto provide classes where boys and girls will work side by side under the same teacher,with the same classroom condition,for an in-depth study and to avoid interclass discussion.

Table 3.2: - Sample Size for the Study

S/N	Name of Schools	Gender		
		Male	**Female**	**Total**
1	Govt. Secondary School, SabonGari	38	38	76
2	Govt. Secondary School, Kwangila	38	36	74
3	Govt. Secondary School, Yakasai	36	34	70
4	Govt. Secondary School, Pada	32	38	70
	Total	**144**	**146**	**290**

This sample size is sufficient enough for the study as it conforms with sizes recommended by Afolabi (2001). The Geometry Achievement Test (GAT) was administered to the samples of each of the four schools selected as pretest. This was to ensure the equivalence of the subjects at the start of the work.

3.5 Instrumentation

The following instruments were developed by the researcher and used for data collection

1) Geometry Achievement Test (GAT);was used for pretest, posttest and post-posttest(seeAppendix B)
2) Attitudes Toward Geometry Inventory (ATGI): was used to determined any attitude change in mathematics (see Appendix D)

3.5.1 Geometry Achievement Test (GAT)

The GATtest items were constructed based on the topics taught. The GAT test itemswere made up of forty multiple-choice questionswith four options, one

correctthreedistracters, which were based on students'misconceived ideas. The items in the test covered the entire unit taught by the researcher on area of parallelogram, angle of elevation and depression bearing and distancesand three dimensional figures. That GAT test items were constructed to test the subject'sperformance and retention of the concept taught.To ensure an equal distribution of test items over the concept taught a Table of specification as shown in Table 3.3.

The GAT test items with the marking scheme were validated by four experts,two mathematics educators withmathematics background and two mathematics teachersfrom Demonstration Secondary School Zaria. These experts were intimated with the purpose of the study. The points of reference used in assessing GAT wereto check whether:

1. The GAT items are valid, that is whether theyconformwith the subject specification they were to test.
2. The test items are clearly stated and appropriate in terms of the reading difficulty level of the students understanding.

Table 3.3: Table of Items Specification based on Topics Selected

Concept	Knowledge 40%	Comprehension 17.5%	Application 15%	Synthesis 15%	Evaluative 12.5%	Total 100
Angle of elevation and depression	4	3	3	3	2	15
Bearing and distances	4	2	1	1	1	9
Three Dimensional Figure	4	1	1	1	1	8
Area of parallelogram	4	1	1	1	1	8
Total	**16**	**7**	**6**	**6**	**5**	**40**

Source: Obeka, (2010)

3.5.2 Attitude towardGeometry Inventory (ATGI)

This is attitudinal scale adapted from Martha and George (2003). ATGI was developed and recommended for use in the investigation of students' attitudes toward Geometry. Attitude toward Geometry Inventory (ATGI) were made up of statements relevant to Geometry teaching and learning. It consists two sections (A and B). Section A solicits for personal information about students, such as school type, gender, ageand class. Section B consists of 20 items which were rated on five point likertscale of Strongly Agree (SA), Agree (A), Disagree (D), Uncertain (UN) and Strongly Disagree SD. The questionnaire was administered to both experimental and control group. The detail of the questionnaire is in Appendix D.

3.6 Validation of the Geometry achievement test (GAT)

The geometry achievement test (GAT) items with the marking scheme were validated by fourexperts made up of twomathematics educators with mathematics background and twoexperienced mathematics teachers from Demonstration Secondary School, Zaria. Theseexperts were intimated with the purpose of the study, and the content to be covered for five weeks teaching period. The experts gave both face and content validity of the instrument such as conformity of thetest items with the subject specification clarityand appropriateness of the items, ability of the items to actually test basic ideas in geometry

3.6.1 Validation of Attitude towardGeometry (ATGI)

The attitudetowardsGeometryinventory (ATGI) was validated by two mathematics educators, one psychologist and one senior languagespecialist from Ahmadu Bello University. The 20 items on the questionnaire were presented for face validation. The facevalidity of theinstrument was improved through the inputsfrom the panel members who were requested to examine the items of the instrument in relation to:

i. Are items clear, appropriate and free from ambiguity?
ii. What general criticism and suggestions could yougive to improve theinstrument?

Based on thecritique and suggestions from theexperts theresearcheraccepted to make all thenecessary correction and amendment before final production.

3.7 Reliability of the Instruments

The data generated from the pilot study was used to determine the reliability coefficients of the test instruments.

3.7.1 Geometry Achievement Test (GAT):to test the reliability of Geometry Achievement Test (GAT)a test retest approach was applied with interval of two weeks between the first and second test in lines withTuckman(1975)recommendation. This study employedPearson'sproduct moment correlation coefficient (PPMCC), formula on the scores obtained because it has been found byOlayiwola (2007) to be particularly useful to teachers, as it requires less computationand is useful whenitems are inmultiple response form. Using SPSS,a reliabilityr = 0.76was found and indicated that theinstrument is reliable

3.7.2 Attitude towardsGeometry Inventory (ATGI):for the reliability ofATGI,the researcher adopted a spilt half method of Gottmans by this method it involves the division of each instrument to be engaged in a pilot study. The reliability of ATGI was established using spearman Brown coefficient.The reliability coefficient for the ATGI was determined which was found to be 0.89 also indicatedthat the instrument is reliable.

3.8 Administration of the Treatment

Two instructional strategies were used for this study namely:

- The mathematics laboratory instructional strategy adapted from Manjunath (2008) was used for experimental group and
- Conventional- lecture method was used in teaching the same concepts to the control group.

In the four co-educational schools chosen for the study, two intact classes from two schools were taught using laboratory instructional strategy. These two intact classes form the experimental groups. Laboratory instructional strategy is about verifying and visualizing mathematical concepts ina fun way through educational aids it is basedon "learning by doing" more often than not it involves students playing and manipulating concrete objects in structured situations. Teachers designinstruction around a learning objective gathers resources and provide students with an opportunity to explore, build and demonstrate their learning. It shifts the learning environment from onewhich is very instructor centre to one that is very learner centered.Twointact classes form the experimentalgroups, the students prepare models and aids for the lesson. Each student had to participateactively in the class discussion. When guidance is needed the teacher asks openended general questions. Each student had to conduct an independent study and participate actively in the class discussion.(See Appendix E).

LABORATORY INSTRUCTIONAL MODEL

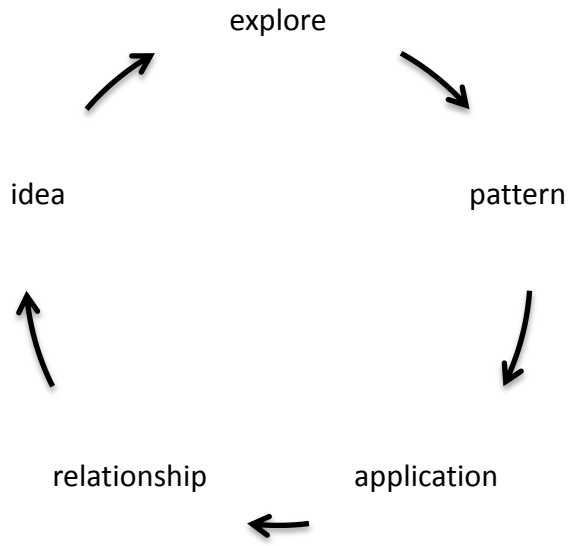


Fig. 2: Flowchart of Laboratory Instructional Model

- Explore: Students explore a relationshipby manipulating simple object.
- Pattern: studentsfind pattern by drawing or construction.
- Application: students discover a scientific principle by performingexperiment with simple equipment.
- Relationship: students collect original data from a survey to determined what variables are related
- Idea: students represents a mathematical ideaby building a simple model

As the leaner does these he records and writes conclusions. In the process, the learner invented ways of shorting labour and learnt to compute better, this is an experience that gives the learner new confidence in his ability to learn.

Two intact classes from two schools different from those used in the experimental group were the control group. The control group were taught using conventional teaching method. They were taught using traditional teaching method for a period of six weeks at the rate of five hours per week. The lesson note which were prepared by the researcher and validated by the panel of the educationistswere strictly adhered to in the teaching of control group, (Appendix F). The lessons were presented using conventional teaching method with important points written on the chalkboard. Class works were given to the student after each teaching period and written assignmentswere given to the studentsafter each lesson. The entire teaching lasted for six weeks,study was conducted in the school classroom atthe time of normal classes.Before starting to teach GAT and ATGI were given to the students to answer and respond to respectively and no feedbackonpretest achievement was given to them. This measure was used to reducehawthorn effect.

3.9 Procedure for Data Collection

The GAT and ATGI were administered to the students before treatment started and from this pre-test results were obtained. Immediately after the six weeks teaching (treatment) period, the same instruments were administered to the same students in their classrooms under the same classroom conditions but this time, the test items were re-arranged (Appendix C). For GAT, the test lasted for 1 hour andquestionnaires that include a set of specific mathematics statement were administered to control and experimental group after the treatment. The teachers of

the participating classes in each school administered the tests under the guidance of the researcher to avoid experimentalbias. The sametestwasadministered as post – posttest, after two weeks from the date of the last test. The maximum score obtainable was 100,the different scores obtained during pretest, post-test and post-posttest were used for data analysis.

3.10 Procedure for Data Analysis

The responses of the subjects in the Geometry Achievement Test (GAT) were scored using the marking scheme shown in Appendix B. Probability level $P \leq 0.05$ was used for retaining or rejecting the stated null hypotheses. The null hypotheses are re-stated below and the statistical analysis used as follows:

$HO_{1:}$There is no significant difference between the mean performancescores of students taught geometry using laboratory instructional strategy and those taught using conventional method.

HO_2: There is no significant difference between the mean performance scores of male and female JS II students taught geometry using laboratory instructional strategy, t-test statistics was used to test the hypothesis.

HO_3: There is no significant difference in the mean retention score of JSS II students exposed to mathematics laboratory instructional strategy and those exposed to conventional instruction, t-test statistics was used to test the hypothesis.

HO_4: There is no significance difference between the mean attitude score of male and female student taught geometry using laboratory instructional strategy, t-test statistics was used to test the hypothesis.

HO_5: There is no significant difference between the mean rankscores of JSS II students taught geometry with laboratory instructional strategy and those taught with conventional method. Mann Whitney U-test statistics was used to test the hypothesis.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS,RESULTS AND DISCUSSIONS

4.1 Introduction

This Chapter presents the data analysis and discussions arising from the results. The study titled Efficacy of Laboratory Instructional Strategy on Students geometry performance, Retention and Attitude in Junior Secondary Schools in Zaria, Kaduna State, Nigeria. The chapter involves a total of 150 experimental and 140 control group students. Altogether 290 respondents were used for this study.The first section answers the comparative research questions using item frequencies, means and standard deviations as perceived by each of the three categories of respondents. The second section presents and interprets the five null research hypotheses by means of inferential statistical techniques of Independent test and MannWhitney U-teststatistics. All hypotheses are being tested at 0.05 alpha level of significance. The third section outlined the major findings of the study and the last section discussed the findings of the study in details.

4.2: Data Presentation

The data presented in form of tables provided answers to the research questions which were used in testing the hypotheses.

Table 4.2.1:Descriptive statistics on efficacy of laboratory teaching strategy on academic performance in geometryusing the scores of experimental and control group students

Variable	Group	N	Mean	Std.dev	Mean Diff.
Academic	Experimental	150	24.22	3.70	4.18
performance	Control	140	20.04	2.83	

Result of the table 4.2.1 revealed thatthe mean performancescores of students taught with the laboratory teaching strategy in geometry was 24.22while those taught geometry with the conventional teaching method was 20.04. This shows thattherewas a positive achievement in geometry concepts among JSS II students.

Table 4.2.2: Descriptive statistics on the differences between the performance of male and female students taught geometryusing laboratory teaching strategy.

Variable	Gender	N	Mean	Std.dev.	Mean Diff
Academic	Male	76	24.00	3.61	0.44
Performance	Female	74	24.44	3.80	

The descriptive statistics Table 4.2.2revealed the differences between the performance of male and female students taught geometry concepts using laboratory teaching strategy. According to the table their mean academic performance were24.00 and 24.44 by males and female JSSII students respectively. This shows a marginal difference of 0.44 in favor of the female students. This difference is not significant, implying that the laboratory teaching strategy is good for both male and female JSS II students in the teaching of geometry.

Table 4.2.3: Descriptive statistics on retention level of the concept in geometry among JSS II students using mean post post-test scores ofexperimental andcontrol group.

Variable	Groups	N	Mean	Std.dev.	Mean Diff
Retention	Experimental	150	27.58	3.15	4.78
	Control	140	22.80	2.69	

Data in the Table 4.2.3 reveals that there are significant differencesofmean retention scores of students exposed to laboratory instructional strategyand those exposed to conventional methodwith experimental group having higher mean (27.58)with the control group had the lower mean (22.80).

Table 4.2.4: Descriptive statistics on differences between the meanmathematics attitude scores of maleand femaleJSS II students taught with mathematical laboratory instructional strategy.

Variable	Gender	N	Mean	Std. dev	Mean Diff
Attitude	Male	76	24.43	3.79	0.23
	Female	74	24.20	3.27	

The descriptive statistics of the Table 4.2.4 shows the difference between the meanattitude scores of maleand female JSS II students in experimental group.The mean attitude score of male was 24.43 and that of female was 24.20 with a marginal difference of 0.23 infavor of male student. This difference is not significant, implying that the mathematical laboratory instructional strategy is gender friendly.

Table 4.2.5: Descriptive Statistics of Experimental and Control Group Students Attitude Toward Geometry

Variable	Group	N	Mean
Attitude	Experimental	150	3.81
	Control	140	3.01

The Table 4.2.5showed thechangein the attitude towards Mathematics between students exposed to laboratory instructional strategy and those exposed to conventional method. It showed that students who are exposed to Laboratory instructional strategy have positive attitude towards mathematics than those exposed to conventional method. For instance majority of the control students have difficulty in understanding the language used in teaching geometry with item.

Mean attitude of 3.81as compared to that of experimental students with reduced item mean attitude of 3.01. The details showed that while 53 of the control students strongly agreed of having difficulty understanding language used in teaching geometry, only 23 of the experimental students strongly agreed with the same item. This shows that there has been a significant change in attitude towards mathematics between students exposed to laboratory instructional strategy and their counterparts that were exposed to conventional method.

4.3 Hypotheses Testing

Based on the research questions, five null hypotheses were formulated and tested at 0.05 level of significance the hypotheses were tested using T-Test and Mann-Whitney U-test

Hypothesis One : This null hypothesis state that there is no significantdifference between the mean scores of students taught geometry usinglaboratory instructional strategy (experimental group) and those taught using conventional method (control group)

Table 4.3.1:Summary ofIndependent t-test of the Academic performance between Experimental Group and Control Group Students

Variable	Group	N	Mean	Std.dev	Std. Err	Df	t calculated	t-critical	Sig (p)	Remark
Academic performance	Experimental	150	24.22	3.70	.30	288	7.73	1.96	0.000	Sig
	Control	140	20.04	2.83	.24					

Significant at p≤ 0.05

In Table 4.3.1results of the independent t-test statistics showedthat significantdifference exist between experimental group and control group students in their academic performance. Reason being that the calculated p value of 0.00 is less than the 0.05 alpha level of significance while the t-calculated value of 7.73 is higher than the t-critical value of 1.96, at df 288. Their calculated mean academic performances were24.22and 20.04by experimental group and control group students respectively. Consequently the null hypothesis which statesthat there is no

significant difference between experimental group and control group students in their academic performance is hereby rejected. This means that there is significant difference between the post-test scores of the experimental and the control group. Thus the hypothesis is rejected. This implies that the experimental strategyachieved significantly higher than the control group taught thesame concept.

Hypothesis Two: This null hypothesis state that there is no significantdifference in the mean scores of male and female JSS II students taught geometry using laboratory instructional strategy (experimental group).

Table 4.3.2:Summary of Independent t-test Sample Statistics in theMean Scores of Male and Female JSS II Students Taught geometryUsing Laboratory Instructional Strategy (Experimental Group)

Gender (Experimental group)	N	Mean	Std.Dev	Std. Err	Df	t calculated	t critical	Sig (P)	Remark
Male	76	24.00	3.61	41	148	0.73	1.96	0.47	Not sig
Female	74	24.44	3.80	44					

Not significant at p > 0.5

Results of the independent t-test statistics in Table 4.3.2showed that there is no significant difference in the mean scores of male and female JSS II students taught mathematics concept using laboratory instructional strategy (experimental group) Reason being that the calculated p value of 0.47 is greater than the 0.05 alpha level of significance while the t-calculated value of 0.73 is less than the t-critical value of 1.96, at df148. Their calculated mean academic performances

were24.00 and 24.44by male and female experimental group students respectively. Consequently the null hypothesis which state that there is no significant difference in the mean scores of male and female JSS II students taughtgeometryusing laboratory instructional strategy (experimental group), is hereby retained.

Hypothesis three:this hypothesis state that there is no significant difference in the mean retention scores of the concept in geometry between JSS II studentsexposed tomathematical laboratory instructional strategy (experimental) and thoseexposed to conventional method (control group).

Table 4.3.3: Independent t-test sample statistics in the retentionlevel using post-post test betweenexperimental group and control group students.

Variable	Group	N	Mean	Std. dev	Std. Err	Df	t calculated	t-critical	Sig (p)	Remark
Retention	Experimental	150	27.58	3.15	0.46	288	7.30	1.96	0.00	Sig.
	Control	140	22.80	2.69	0.41					

Significant at p≤ 0.05

From Table 4.3.3 above the t-table value is 1.96 while t-calculated value for retention level of concept in geometry betweensubjects exposed to laboratory instructional strategyand those exposed to conventional method is 7.30 this value is greater than the table value and therefore shows that there is a significant difference between subjectsin the experimental group and control group in terms of retention

with the laboratory instructional strategywith a mean of27.58performing better than those in the control group with a mean of 22.80. This means the retention of hypothesis three meaning there is a significant difference in thestudent's retention level of the concept in geometry between subjects exposedto laboratory instructional strategy and those exposed to conventionalmethod withexperimental group performing better.

Hypothesis four: This hypothesis state thatthere is no significant difference in the mean attitude scores between male and female students at the end of teaching the conceptin geometry using laboratory instructional strategy.

Table 4.3.4:Summary of t-test onAttitude Scores between Male and Female Students Taught geometrywithLaboratory Instructional Strategy (Experimental Group)

Variable	Gender	N	Mean	Std. Dev	Df	t-Calculated	t-Critical	Sig. (P)	Remark
Attitude	Male	76	3.79	0.44	148	0.78	1.96	0.45	Not sig.
	Female	74	3.27	0.38					

Not significant at p> 0.05

From Table 4.3.4the calculated t-value is 0.78, this is less than the critical value of 1.96 at degree of freedom (*df*) =148. This means there is no significant difference between attitude of male and female in theexperimental group.It is empiricallyeffect on students attitude in mathematics. The null hypothesis is thus accepted, it is also clear from table 4.9 that P-value level of significance with df=148. This means that there is

no significant difference in the attitude between male and female students exposed to laboratory instructional strategy. Thus, the hypothesis is retained.

Hypothesis Five: This hypothesis state that there is no significant difference between attitude of JSSII students taught geometry laboratory instructional strategy.

Table 4.3.5: Mann-Whitney U-Test on attitude scores of JSS II students taught geometry with laboratory instructional strategy and those taught geometry with conventional method

Ranks

	Groups	N	Mean Rank	Sum of Ranks	Z calculated	Sig (p)	Remark
LEVEL OF ATTITUDE	Experimental	150	165.56	24834.00			
	Control	140	124.01	17361.00	4.22	0.00	Sig
	Total	290					

Significant at p≤ 0.05

Result of theNon parametric test of Mann-Whitney testTable 4.3.5 showed the mean rankings of JSS Mathematics students level of attitudes towards Mathematicsbetween experimental and control group students in the junior secondary schools in Kaduna state. The result showed that significant differences exist between experimental and control group students in their level of attitude towards Mathematics in the junior secondary schools in Kaduna stateThis is because the calculated significant value of 0.00 is lower than the 0.05 alpha value of significance. Their mean level of attitude rankingswere 165.56 and 124.01 by experimental and control group respectively. This showsthat experimental group of students had significantly higher mean level of attitude toward Mathematics than their counterparts in control

group that were not exposed to the treatment. Therefore the null hypothesis which statesthat there is no significant difference between the mean attitude scores of JSS II students taught geometry with laboratory instructional strategy(experimental) and those taught geometry with conventional method (control group) is hereby rejected.

4.4 Summary of Major Findings

The following are the major findings of the study

1. There is significant difference in the academic performance of students exposed to laboratory instructional strategy and those exposed to the conventional method in favor of the experimental group.
2. There is no significant difference between male and female students exposed to laboratory instructional teaching strategy. Thus, indicating that the strategy is not gender selective.
3. Thereis significant difference in retention level of mathematics concept taught using laboratory instructional strategy compare to those exposed to conventional teaching method, for instance, there has been change in students ability to lead a group practical work in geometry lesson.
4. students exposed to laboratory instructional strategy developed more positive attitude to mathematics than those exposed to conventional method of teaching, for instance majority of the control students have difficult in understanding the language used in teaching geometry.

4.5 Discussions on Findings

The discussion on findings was done in relation to outcome of the research hypotheses and research questions

4.3.1 One:

Result in Table 4.6 showed that significant difference exist between students exposed to mathematical laboratory instructional strategy teaching and (experimental group) and those exposed to conventional method in their mathematics academic performance. Their calculated mean academic performances were24.22 and 20.04by experimental group and control group students respectively. The result of this hypothesis enables the null hypothesis to be rejected. This outcome is expected as students who were exposed to the laboratory instructional teaching strategy is exposed to various teaching aids such as charts, symbols that enhance their academic performance in the subject. The result of this study agreed with that of Manjunath (2008) where he discovered that students taught with mathematical laboratory instructional strategy performed significantly better than the control group in geometry. The superiority of the strategy over the conventional teaching method has also been reported by Etukudo (2006), who carried out a study on the effect of laboratory and discussion method of teaching on students' performance in mathematics at the secondary school level.

4.3.2 Two:

Outcome in Table 4.7 revealed that there is no significant differences in the mean scores of male and female JSS II students taught Geometry concept using laboratory instructional strategy (experimental group). This enables the null hypothesis to be retained and accepted. Their calculated mean academic performances were24.00and 24.44 by male and female experimental group students respectively. The implication of this result is that the treatment is good for both male and female students alike. It is not gender selective. This outcome is not surprising as both male and female students were exposed to the treatment. The findings of this study is in line with Janet (2008), Okigbo and Osuafor (2008). The fact that neither the male nor the female performed significantly better than the other seem to make the method gender friendly.

4.3.3 Three:

Result of Table 4.8 showed that there is significant difference between the retention level of students exposed to laboratory instructional strategy and those exposed to the conventional method in favor of the experimental group. Studies on retention and instructional strategies seems to agree that those instructional strategies that are characterized by active learning such as mathematical laboratory instructional strategy yield permanent and meaningful learning that is readily retained and remembered at will by the learner Yadar (2007).

4.3.4 Four:

Outcome of Table 4.3.4 revealed that there is no significant difference between the attitude of maleand female students at the end of teaching Geometry concept using laboratory instructional strategy. The mean attitude score of male was 24.43 while that of female is 24.20. This showed a marginal difference of 0.23 in favour of male student this support the view of Nworgu (2005) that mathematics is more of boys than girls favorite even when different techniques were used the test significant review that there is no significant change in the attitude of male and female student in the experimental group. This finding was in line with the finding of Imoko and Agwagah (2006) the concept making technique enhancing male and female attitude in trigonometric equally.

4.3.5 Five:

Result of Table 4.3.5on theNon parametric test of Mann-Whitney U-test showed that significant differences exist between students exposed to laboratory instructional teaching method (experimental) and those exposed to conventional method (control group) in their level of attitude towards Mathematics . Their mean *level of attitude r*ankings were 165.56 and 124.01 by experimental and control group respectively. This shows that experimental group of students had significantly higher mean level of attitude towards Mathematics than their counterparts in control group that were not exposed to the treatment. For instance majority of the control students have difficulty in understanding the language used

in teaching geometry with item mean attitude of 3.81 as compared to that of experimental students with reduced item mean attitude of 3.01. The details showed that while 53 of the control students strongly agreed of having difficulty understanding language used in teaching geometry, only 23 of the experimental students strongly agreed with the same item. This finding is in conformity with Bolaji (2005), Akinsola and Olowojeye (2008) who found that teacher methods of mathematics teaching accounted for the students positive attitude towards mathematics

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This study assessed the efficacy of laboratory instructional strategy on students' geometry performance, retention and attitude among junior secondary schools of Zaria Educational Zone. The chapter presents the conclusion, limitations, recommendations and suggestions for further research. It also includes the summary of the entire work.

5.2 Summary

This study investigated efficacy of laboratory instructional strategy onstudents'geometry performance, retention and attitude of students taughtgeometry in Kaduna State Junior Secondary Schools. It alsoassessed efficacy of gender related differences on students'performance in geometrywhen exposed tolaboratory instructional strategy. The study was guided by five research questions. Also five null hypotheses were formulated and tested at 0.05 levels of significance. The study employed pre-test, post-test quasi experimental design. The population comprised of 5,483 junior secondary two (JS2) mathematics students found in twenty four (24) co-educational schools in Zaria Educational Zone of Kaduna state. The study sampled two hundred and ninety (290) JSII students randomly drawn from four public secondary schools. They were selected by simple random sampling technique (balloting with replacement).the subjects were divided into two groups,

the experimental group N=150 and the control group N=140.Four intact classesfrom four schools were taught geometry for six weeks data on performance, retention and attitude were obtained using Geometry Achievement Test (GAT)and Attitude Toward Geometry Inventory (ATGI) respectively. The GAT, ATGI and lesson plan constructed were face and content validated by mathematics educators, one psychologist and one senior language specialist. The reliability of GAT was established using Pearson's product moment correlation coefficient (PPMCC) which was found to be0.76while the reliability of ATGIwas obtained using spearman brown coefficient which was found to be 0.89.mean and standard deviation were used to provide answers to the research questions posed. The t-test was used to test hypotheses one, two three and four while hypothesis five was tested using Mann-Whitney U-test statistics. The study showed that students exposed to laboratory instructional strategy achieved, retained the learnt concept and developed more positive attitude to geometry than their counterpart exposed to conventional method; laboratory instructional strategy enhanced performance and attitude of female and male mathematics students equally.

The researcher recommended that; mathematics teachers should be encouraged to use laboratory instructional strategy by providing allthe materials needed for effective implementation; students attitude toward mathematics should be positively changed by involving them to participate actively in the learning process.

5.3 Conclusion

Based on the findings and interpretation of the study, the following conclusions are deduced.

- Students exposed to laboratory teaching strategy had significantly higher academic achievement than their counterparts that were exposed only to the conventional method.
- The laboratory instructional teaching strategy is suitable for both male and female students in the teaching and learning of mathematics.
- Mathematics concepts are retained when laboratory instructional strategy was usedas a medium of instruction for junior secondary mathematics students

5.4 Recommendations

The following recommendations are hereby put forward as a result of the findings from the study.

1. Mathematics teachers should be encouraged to use the laboratory instructional strategy by providing all the necessary materials needed for its effective implementation.
2. Mathematics teachers should be motivated by sponsoring them to attend seminars, workshops and paper presentations in modern techniques of teaching mathematics.

3. Students'retention in mathematics should be sustained by effective teaching methods, good teacher-students relationship and use of symbols in forms of practical instructions.
4. Students'attitude towards mathematics should be positively changed by involving them to participate actively in the learning process.

5.5 Limitation of the Study

This study has some limitations which include:

1. The study used geometry achievement test items that are made up of forty multiple-choice questions with four options, one correct, three distracters, which were based on students' misconceived ideas.
2. The restriction to only four junior secondary schools in Kaduna state made the scope of the generalizations that can be made from the study fairly narrow.

5.6 Suggestions for Further Studies

The following suggestions were provided for further research in relevant areas:

- Relationship between students' attitude and retention on the Academic performance of Mathematics students in Senior Secondary Schools of Kaduna state.

- A study is suggested on the efficacy of laboratory instructional strategy on the interest of Geometry concepts.
- A similar study should be carried out focusing on the teaching of Geometryusing laboratory instructional method with a view of finding out if similar or different results as in this study might be obtained.

5.7 Contribution to Knowledge

1. The study established how laboratory instructional strategy can improve junior secondary school mathematics student academic performance.
2. Instruments developed Geometry achievement test (GAT) and attitude towards Geometry inventory (ATGI) were all developed by the researcher can be used by other researchers.
3. The study on geometry using laboratory instructional strategy is relatively new at Junior Secondary in Zaria Educational Zone. Most studies are on trigonometry and are the first of its kind. Laboratory instructional strategy has potentiality of enhancing mathematics positively at junior secondary level. Therefore laboratory instructional strategy has potentiality of enhancing mathematics positively at junior secondary school

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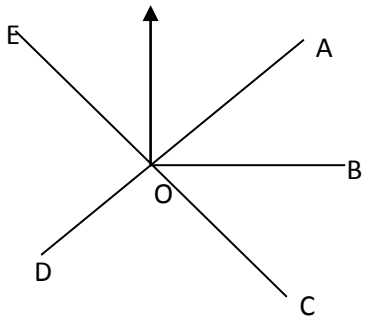
APPENDIX A

Geometry Achievement Test (GAT) I

Instruction: - The questions below are meant to assess the students Geometry Achievement, the result will be used only for research work. Therefore attempt all questions by circling the correct option.

Time Allowed: 1hr

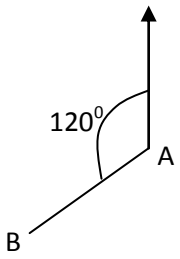
1) Find the angle turning clockwise from the southwest direction to the east direction.
   a) 135^0b) 45^0c) 315^0d) 225^0e) 300^0
2) Find the angle turning anticlockwise from the north direction to the south east direction.
   a) 135^0b) 45^0c) 270^0d) 225^0e) 105^0
3) Convert the bearing 269^0 to a compass bearing.
   a) 589^0Eb) 589^0W c) N89^0W d) N31^0We) N31^0E
4) The bearing of X from Y is 127^0. Find the bearing of Y from X?
   a) 307^0b) 053^0c) 127^0 d) 223^0e) 123^0
5) Which of the point A, B, C D, E in the figure below on a bearing 230^0 from O?



6) A village is 10km on bearing 050^0 from a point 0. Calculate how far the village is North of 0.

a) 4.4kmb) 6.4km c) 6.6kmd) 6.7kme)7.1km

7) What is the bearing of B from A in the diagram below?



a) 060^0b) 120^0c) 220^0d) 240^0e) 300^0

8) A girl starts at a point X and walks 3km due East to Y. She then walks 4km due North to Z. Find the bearing of Z from X to the nearest whole degree?

a) 037^0b) 045^0c) 058^0d) 060^0e) 090^0

9) Which pair of angles are supplementary?

a) 47^0, 83^0b) 60^0, 60^0c) 38^0, 52^0 d) 160^0, 20^0e) 90^0, 80^0

10) The acute angle between the hands of a clock at 6:20 is _____

a) 180^0b) 120^0c) 90^0d) 60^0e) 30^0

11) If the angle of elevation of P from Q is 380 then the angle of depression of Q from P is?

a) 19^0b) 38^0c) 52^0d) 128^0e) 142^0

12) The height of a man is equal to the length of his shadow, the angle of elevation of the sun is?

a) 0^0b) 30^0c) 450^0d) 60^0e) 90^0

13) The angle of elevation of the top of a tree from a point on the level of ground is 45^0. If the tree is 12m high calculate the length from the foot of the tree to the point on the ground where the observation was made?

a) 36mb) 12mc) 6md) 24me) 18m

14) From the top of a building, a boy is watching a lizard on the ground. If the angle of depression of the lizard is 45^0 and the lizard is 15m away from the building, how high is the building.

a) 10mb) 12mc) 15md) 35me) 65m

15) The angle of elevation of the top of an electric pole to a man standing 10m from it is 60^0. Find the length of the pole.

a) 70mb) $60\tan10^0$mc) $10\tan60^0$md) $60\cos10^0$m e) $10\tan70^0$m

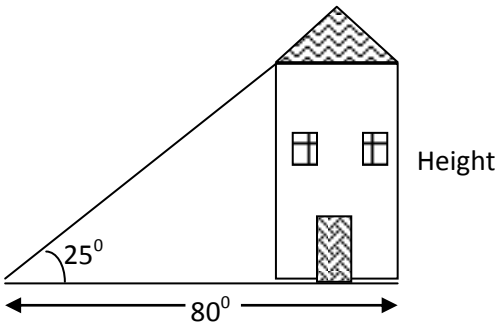
16) The angle of elevation and depression are equal because they are usually …….. angles.

a) Adjacentb) Alliedc) Alternated) Complimentary e) Corresponding

17) Angle of elevation and depression can be measure with a simple instrument called _____

a) Astrolabeb) Thermometerc) Barometerd) Plumblinee) Roller

18) Calculate the height of the building below to 2 significant figures



19) From the top of a tower 14m high, the angle of depression of a boy is 32^0. Find the distance of the boy from the foot of the tower.

a) 20½m b) 22½mc) 24½md) 25½me) 26½m

20) A pole 4m long leans against a vertical wall. If the foot of the pole is 2m from the wall. Find the angle which the pole makes with the wall.
a) 15^0b) 180^0c) 20^0d) 25^0e) 60^0

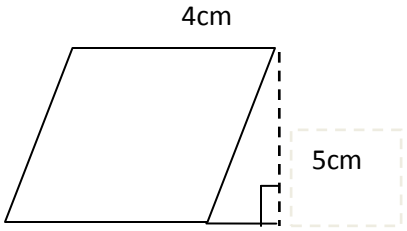
21) Find the area of parallelogram whose height is $2^{1/2cm}$ base 12cm (a) 40cm (b) $35cm^2$(c) $25cm^2$ (d)30cm2 (e) $20cm^2$

22) Calculate the area of a parallelogram whose base is 16cm and height is 1.6cm (a) $256cm^2$ (b) $18.0cm^2$ (c) $25.6cm^2$ (d) $17.6cm^2$ (e) $2.56cm^2$

23) The area of a parallelogram is 136.8cm2 if it is 3.6cm high, find the base
a) 38cm b) 83cm c) 6.8cm d)136cm e) 48cm

24) Calculate the area of a parallelogram whose base is 54mm and height is 25.5mm, leaving your answers in cm^2
a) $1377mm^2$ b) $100mm^2$ c) $13.77cm^2$ d) $3377mm^2$ e) $137cm^2$

25) The area of the figure below is ----------

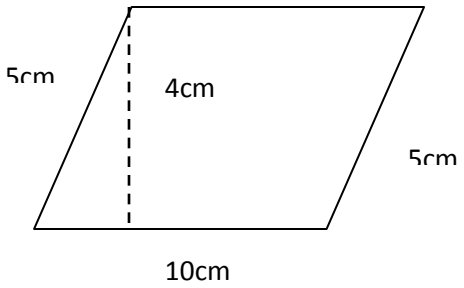


a) $30cm^2$ b) $15cm^2$ c) $20cm^2$ d) 9cm2 e)$5cm^2$

26) If the area of a parallelogram is $720m^2$ and its base is 24cm find the height of the parallelogram
a) 32.0m b) 28.0m c) 25.0m d) 30.0m e)36.0m

27) Calculate the area of a parallelogram of height 6cm and base 9cm
a) $54cm^2$ b) $60cm^2$ c) $15cm^2$ d) $84cm^2$ e) $27cm^2$

28) What is the area of the parallelogram below



a)100cm^2 b) 40cm^2 c) 50cm^2 e) 20cm^2

29) Area of a parallelogram is ----------

a) ½ base x height b) ½ base +height c) base x height d) length x breath e) circumference x diameter

30) Find the probability that when a coin is thrown 4 times the number of heads that appear is exactly 3?

a) ½ b) ¼c) 7/16d) 5/16e) 1/3

31) What is the shape of the plane face of a cylinder?

a) Circleb) Rectangle c) Solidd) Squaree) Triangle

32) A line that divides a circle into two equal parts is known as?

a) Chordb) Diameter c) Radiuse) Divider d) Sector

33) Find the area of a rectangular field whose length is 100cm and whose width is 90cm?

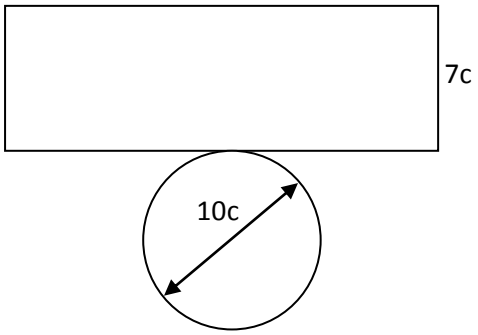
a) 1000cm^{2}b) 8000cm^2 c) 9000cm^{2}d) 8500cm^{2}e) 9500cm^2

34) The area of a circle is given by

a) $2\pi r$ b) πr^2 c) $2\pi r^2$ d) πr e) $2\pi^2 r$

Use the figure C1 below to answer question 27 and 28.

C1



The figure C1 shows the net of a cylinder. If the net is folded to make the cylinder.

35) What is the radius of the cylinder?

a) 5cm b) 10cm c) 7cm d) 20cm e) 25cm

36) What is the height of the cylinder?

a) 5cm b) 10cm c) 7cm d) 20cm e) 25cm

37) Use the value 22/7 for π to find the circumference of a circle of radius 28m.

a) 156cm b) 176cm c) 88cm d) 216cm e) 56cm

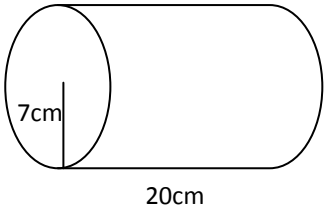
38) A cylinder is of height 5cm and base radius 2cm. Use the value 3.14 for π to calculate the area of its curved surface.

a) $13cm^2$ b) $25cm^2$ c) $31cm^2$ d) $63cm^2$ e) $126cm^2$

39) A strip of thin paper is wound eight times round a cylindrical pencil of diameter 7cm. use the Value 22/7 for π to find the length of the paper (neglect the thickness of the paper).

a) 152cm b) 245cm c) 352cm d) 52cm e) 253cm

40) Find the total surface area of the cylinder below.



a) 152cmb) 245cmc) 352cmd) 52cm e) 253cm

APPENDIX B

The Making Scheme for GAT

1) D	11) B	21) D	31) A
2) D	12) C	22)C	32) B
3) B	13) B	23)A	33) C
4) A	14) C	24) C	34) B
5) D	15) C	25) C	35) A
6) B	16) C	26) D	36) C
7) D	17) A	27) A	37) D
8) A	18) E	28) B	38) A
9) D	19) B	29) C	39) D
10)D	20) E	30) B	40) D

APPENDIX C

Geometry Achievement Test (GAT) II

School:_____

Sex: _____ **Age:** _____

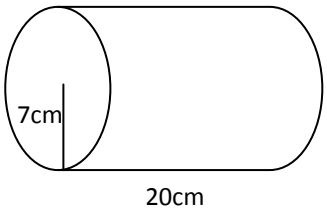
Instruction: - Circle only the right answers (A - E)

Time Allowed: 1hr

1) A cylinder is of height 5cm and base radius 2cm. Use the value 3.14 for π to calculate the area of its curved surface.
   a) 13cm^{2}b) 25cm^2 c) 31cm^{2}d) 63cm^{2}e) 126cm^2

2) A strip of thin paper is wound eight times round a cylindrical pencil of diameter 7mm. use the Value 22/7 for π to find the length of the paper (neglect the thickness of the paper).
   a) 152cmb) 245cmc) 352cmd) 52cme) 253cm

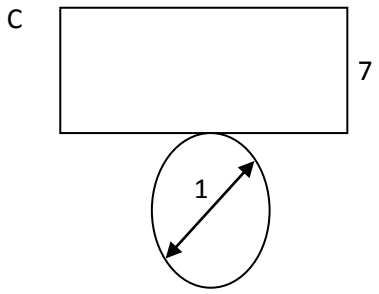
3) Find the total surface area of the cylinder below.



   a) 152cmb) 245cm c) 352cmd) 52cme) 253cm

4) Use the value 22/7 for π to find the circumference of a circle of radius 28m.
   a) 156cmb) 176cmc) 88cmd) 216cm e) 56cm

Use the figure C1 below to answer question 5 and 6.



The figure C1 shows the net of a cylinder. If the net is folded to make the cylinder.

5) What is the height of the cylinder

a) 5cm b) 10cmc) 7cmd) 20cme) 25cm

6) What is the radius of the cylinder?

a) 5cm b) 10cmc) 7cmd) 20cm e) 25cm

7) The area of a circle is given by

a) 2πrb) πr^2c) $2\pi r^2$d) πre) $2\pi^2$r

8) Find the area of a rectangular field whose length is 100cm and whose width is 90cm?

a) 1000cm^2 b) 8000cm^2 c) 9000cm^2d) 8500cm^2e) 9500cm^2

9) A line that divides a circle into two equal parts is known as?

a) Chordb) Diameter c) Radius e) Divider d) Sector

10) What is the shape of the plane face of a cylinder?

a) Circleb) Rectangle c) Solidd) Squaree) Triangle

11) A card is picked at random from a pack of 52 paying cards. The probability that is a 6 is.

a) 1/52b) 1/13c) 3/26d) 1/26e) ¼

12) Find the area of parallelogram whose height is $2^{1/2cm}$ base 12cm (a) 40cm (b) 35cm^2 (c) 25cm^2 (d)30cm2 (e) 20cm^2

13) Calculate the area of a parallelogram whose base is 16cm and height is 1.6cm (a) 256cm^2 (b) 18.0cm^2 (c) 25.6cm^2 (d) 17.6cm^2 (e) 2.56cm^2

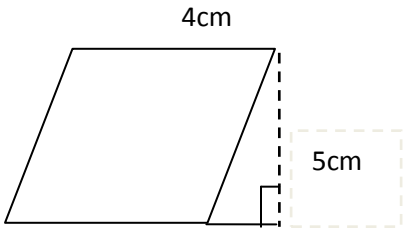
14) The area of a parallelogram is 136.8cm2 if it is 3.6cm high, find the base

b) 38cm b) 83cm c) 6.8cm d)136cm e) 48cm

15) Calculate the area of a parallelogram whose base is 54mm and height is 25.5mm, leaving your answers in cm^2

b) 1377mm^2 b) 100mm^2 c) 13.77cm^2 d) 3377mm^2 e) 137cm^2

16) The area of the figure below is ----------



b) 30cm^2 b) 15cm^2 c) 20cm^2 d) 9cm2 e)5cm^2

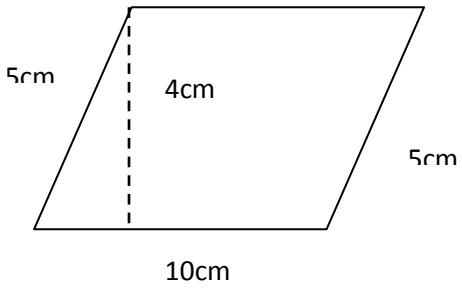
17) If the area of a parallelogram is 720m^2 and its base is 24cm find the height of the parallelogram

b) 32.0m b) 28.0m c) 25.0m d) 30.0m e)36.0m

18) Calculate the area of a parallelogram of height 6cm and base 9cm

b) 54cm^2 b) 60cm^2 c) 15cm^2 d) 84cm^2 e) 27cm^2

19) What is the area of the parallelogram below



a)100cm^2 b) 40cm^2 c) 50cm^2 e) 20cm^2

20) Area of a parallelogram is ----------

a) ½ base x height b) ½ base +height c) base x height d) length x breath e) circumference x diameter

21) The angle of elevation and depression are equal because they are usually …….. angles.

a) Adjacent b) Alliedc) Alternate d) Complimentarye) Corresponding

22) The angle of elevation of the top of an electric pole to a man standing 10m from it is 60^0. Find the length of the pole.

a) 70mb) 60tan10^0m c) 10tan60^0m d) 60cos10^0m e) 10tan70^0m

23) From the top of a building, a boy is watching a lizard on the ground. If the angle of depression of the lizard is 45^0 and the lizard is 15m away from the building, how high is the building.

a) 10mb) 12mc) 15md) 35me) 65m

24) The angle of elevation of the top of a tree from a point on the level of ground is 45^0. If the tree is 12m high calculate the length from the foot of the tree to the point on the ground where the observation was made?

a) 36mb) 12mc) 6md) 24me) 18m

25) The height of a man is equal to the length of his shadow, the angle of elevation of the sun is?

a) 0^0b) 30^0 c) 450^0d) 60^0e) 90^0

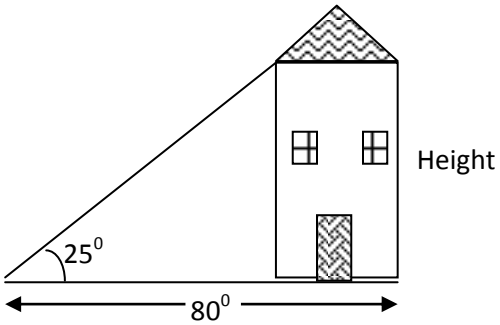
26) If the angle of elevation of P from Q is 380 then the angle of depression of Q from P is?

a) 19^0 b) 38^0c) 52^0d) 128^0 e) 142^0

27) Angle of elevation and depression can be measure with a simple instrument called _____

a) Astrolabeb) Thermometerc) Barometerd) Plumblinee) Roller

28) Calculate the height of the building below to 2 significant figures



29) From the top of a tower 14m high, the angle of depression of a boy is 32^0. Find the distance of the boy from the foot of the tower.

a) 20½m b) 22½mc) 24½md) 25½me) 26½m

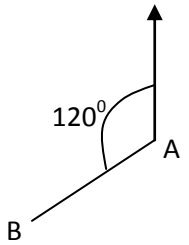
30) A pole 4m long leans against a vertical wall. If the foot of the pole is 2m from the wall. Find the angle which the pole makes with the wall.

a) 15^0b) 180^0c) 20^0d) 25^0e) 60^0

31) A girl starts at a point X and walks 3km due East to Y. She then walks 4km due North to Z. Find the bearing of Z from X to the nearest whole degree?

a) 037^0b) 045^0c) 058^0d) 060^0e) 090^0

32) What is the bearing of B from A in the diagram below?

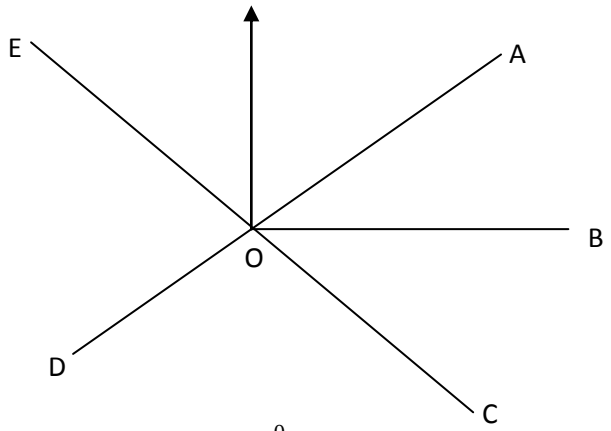


a) 060^0b) 120^0c) 220^0d) 240^0e) 300^0

33) A village is 10km on bearing 050^0 from a point 0. Calculate how far the village is North of 0.

a) 4.4kmb) 6.4km c) 6.6kmd) 6.7kme)7.1km

34) Which of the point A, B, C D, E in the figure below on a bearing 230^0 from O?



35) The bearing of X from Y is 127^0. Find the bearing of Y from X?

a) 307^0b) 053^0c) 127^0d) 223^0e) 123^0

36) Convert the bearing 269^0 to a compass bearing.

a) 589^0Eb) 589^0Wc) N89^0W d) N31^0We) N31^0E

37) Find the angle turning clockwise from the southwest direction to the east direction.

a) 135^0b) 45^0c) 315^0d) 225^0e) 300^0

38) Find the angle turning anticlockwise from the north direction to the south east direction.

a) 135^0 b) 45^0 c) 270^0 d) 225^0 e) 105^0

39) Which pair of angles are supplementary?

a) 47^0, 83^0 b) 60^0, 60^0 c) 38^0, 52^0 d) 160^0, 20^0 e) 90^0, 80^0

40) The acute angle between the hands of a clock at 6:20 is _____

a) 180^0 b) 120^0 c) 90^0 d) 60^0 e) 30^0

APPENDIX D

Attitude TowardsGeometry Inventory (ATGI)

Dear Respondent,

I am a student undergoing Post-Graduate degree in Mathematics Education in Ahmadu Bello University, Zaria.

The purpose of the questionnaire is to collect information on the efficacy of Laboratory Instructional Strategyon the students' performance,retentionand attitude among Junior Secondary Schools in Zaria Educational Zone. Information provided shall be treated with confidentiality.

Thanks for your co-operation.

Instruction

Kindly read each statement carefully and mark (✓) on the appropriate column provided according to how closely you agree or disagree with the statement.

Key:

SD = Strongly Disagree

D = Disagree

UN = Uncertain

A = Agree

SA = Strongly Agree

Section A

Personal Data

Sex: Male ☐ Female ☐

School: _____

Age: _____

Class: _____ **Date:** _____

SN	QUESTION	SD	D	UN	A	SA
1	Geometry is dull and boring					
2	When I hear the word Geometry I have feeling of dislike					
3	Geometry is fascinating and fun					
4	I am happy in a Geometry class than in any other class					
5	Geometry is very interesting to me and I enjoy studying Geometry					
6	I do not like Geometry and it scares me to have take it.					
7	I am able to solve Geometry problem without too much difficultly.					
8	I am always under a terrible strain in a Geometry class					
9	Geometry is something I enjoy a great deal					
10	I fear to read Geometry because it involves cramming formulae					
11	I do not like Geometry because I don't need it for my future career					
12	Knowing too much of Geometry can be dangerous.					
13	Attending Geometry class is a waste of time					
14	Only brilliant students can understand Geometry					
15	I like to lead a group in practical work in Geometryclassroom.					
16	I have difficulty in understanding the language used in teaching geometry					
17	I do not understand angles, bearings and area of cylinders					
18	Our mathematics teacher uses threads and geo-board in teaching geometry					
19	Geometry is the worst topics I hate in mathematics					
20	Geometry has many technical terms that are difficult to remember					

APPENDIX E

MANUAL FOR EXPERIMENTAL GROUP

Instructional Materials Needed:- 12 cm by 12cm geo-boards and pieces of colored threads of about 1 meter long.

A 12cm x 12cm geo-board was formed by making use of a square soft board of about 15 cm x 15 cm sizes. Twelve wire pins were nailed spacing one cm from each other in a row at a distance of two cm from one edge of the board. Similarly 12 rows of pins were nailed squarely at a distance of one cm from row to row (fig i) thus a geo-board was made

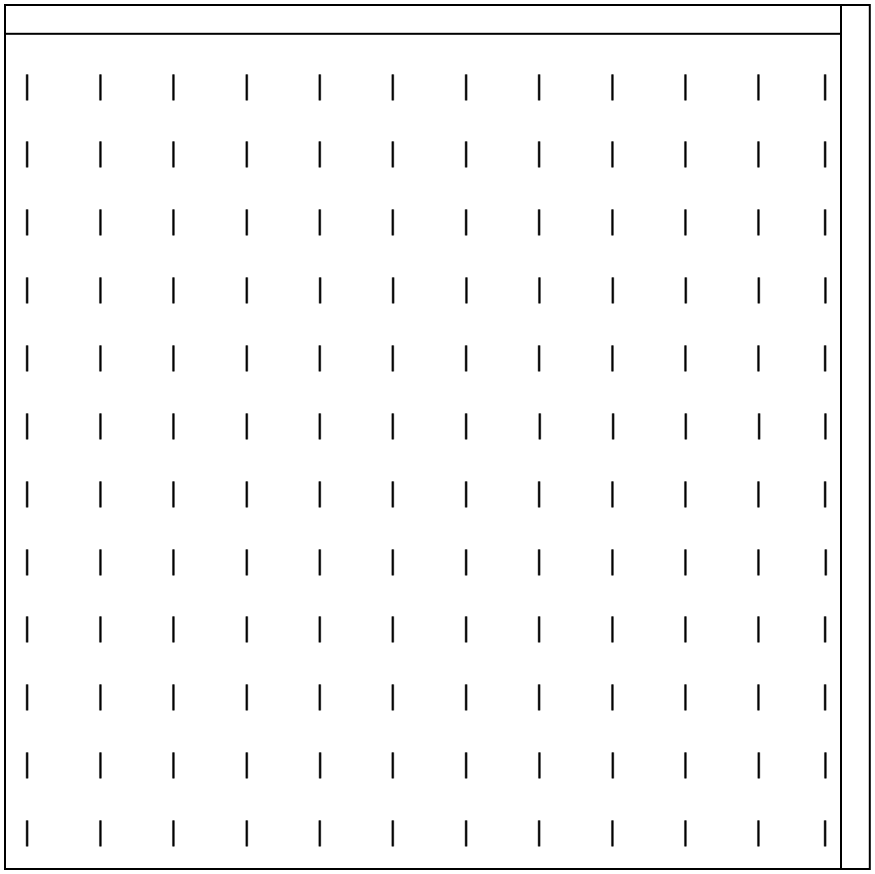


Fig. 1 A 12cm by 12cm geo-board

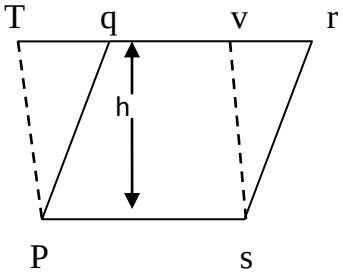
In order for active participation of each student in the experimentation, the experital studentswere divided in to groups one student of a group was randomly selected to act as leader of the group. The students brought wooding boards, one cm nails and colored thread. In a general class they were taught how to make a geo-board. At the beginning of teaching of each topic the teacher distributed guide sheet to the students on what to do. Each student participated in setting up the experimentwhile the teacher goes round to see how the students were doing and also to help in their experimentation. The students were allowed to set up the experiment independently to learn the topics

LESSON 1: AREA OF A PARALLELOGRAM

Activity 1:- students were asked to form a parallelogram using yellow thread

(Fig.2 pqrs)

The base ps was taken by three nails thus length was 2cm while the height h was only between two nails that is 1cm. this parallelogram could be formed in to rectangle by



PARALLELOGRAM FORMED ON A GEO-BOARD

transferringthe triangle rsv to the position of the triangle qpt so that ptvs is arectangle whose base is ps (=2cm whose height is pt (=1 cm).

Therefore area of the parallelogrampqrs.

= the area of the rectangle, ptvs

= psxpt

=2c x 1 cm

= $2cm^2$

From this, it can be deduced that the formula: area of a parallelogram= Base length x distance between two parallel sides

Lesson 2

ANGLE

Material: - Angle made on a circular piece of heavy cardboard showing angles from 0^0 to 360^0. ii) Model of clock on cardboardiii) Angle disciv) Wooden Compass

Activity No 1: - Look and think what you do when

a) You open your door

b) You turn the page of your book

c) You change the volume of the sound in your radio set by means of a knob

d) You try to look at somebody who is on your side

e) When you want to adjust your clock in all these cases we rotate or move the things in:

    i) We move the door about its hinges

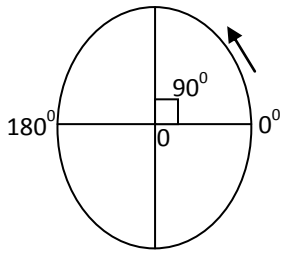
    ii) We move the page of the book

    iii) We rotate the knob in either direction

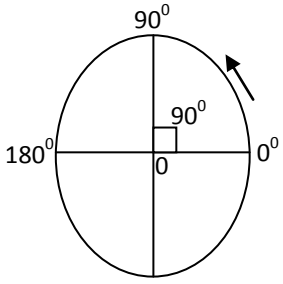
iv) We move our head toward the object

v) We move or rotate the hand of a clock

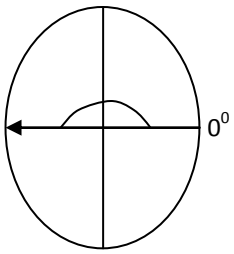
When bicycles or car move its wheels rotate ad the faster you travel the faster the wheels move or rotate. The amount of this movement or rotation is known as ANGLE. Now take your DISC Angle, and put one in the middle joining $0\text{-}180^0$. Fixed the other stick at the centre and put it into $0\text{-}0^0$ position. Now move the moveable stick along the circumference in the anticlockwise direction and watch carefully the different positions. Do you know what is the meaning of anticlockwise direction? If you move towards your left then it is anticlockwise direction and if you move towards right it is known as clockwise direction. Stop for a time when you reach to 90^0. The sticks look like this. This direction shown represents the amount of turning.



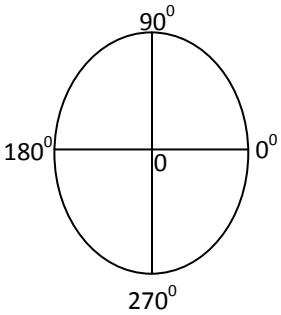
This angle has a special name. do you know the name of this angle? This known as RIGHT ANGLE.



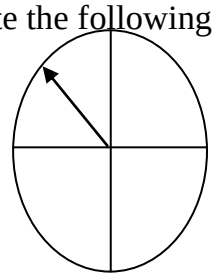
Move again and stops when it comes to 180^0. Now the position looks like this. Here the tow sticks again be on a straight line but in opposite direction. This angle is known as STRAIGHT ANGLE. Could you tell me how many right angles are equal to one straight angle? Yes. We have turned by two right angles. This also known as 'half turn'.

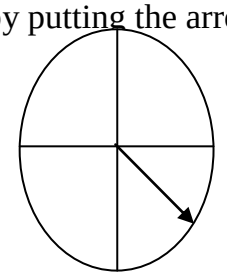


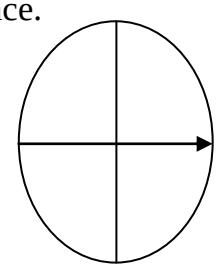
Now move again in the same direction until you get 270^0 position. How many right angles have we rotated from the original position? We have moved by 3 right angles. Moving in the same direction till we reach to the starting point, the position looks as shown in the figure.



How many right angles have we moved? We have completed four right angles since we have arrived at the same position from where we had started, we say we have completed one revolution. Now using your Angle Disc and sticks, complete the following diagrams by putting the arrow at the proper place.







Turn 3 rt angles clockwise	Turn by 235^0 right	Turn by 135^0 anti-clockwise

Start facing north and turn anticlockwise. Write down how many degrees you have turned through when you are facing the following directions:

a) North-West

b) South-West

c) North again

d) North once more

Whenever we have any measurement, we must also have its unit, what is the unit of an angle? Could it be measured in it angles or revolutions? It is not possible as these units are too big. Then what is the unit? The unit which we are using at present was derived by Babylonians who had divided a circle into 360 parts and each of these parts is known as degrees. So we measure the angle in degrees.

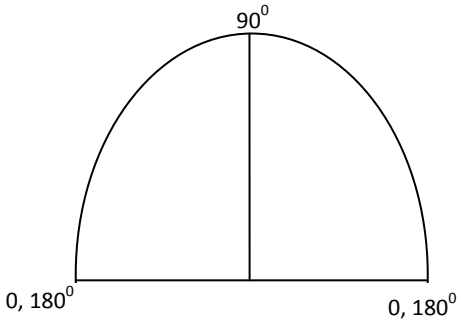
One rt angle = 90^0

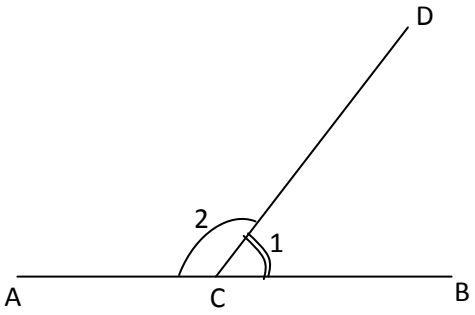
Two rt angles = 180^0 (Half revolution)

One revolution = 360^0

Activity No. 2: - We have learnt about the unit of angles but what about its means of measurement? What is the instrument we are going to use to measure angles? Bring out your mathematical set. You will see an instrument which is semicircular,

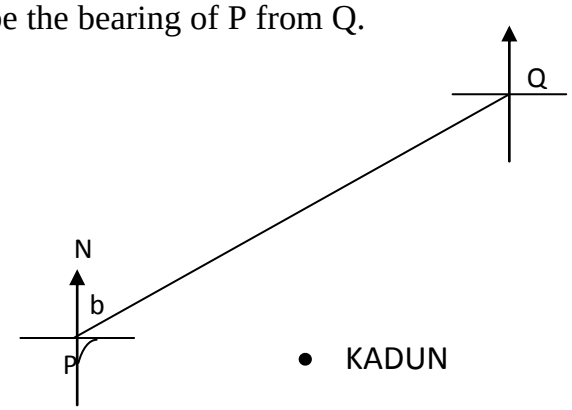
this is used for measuring angles, it is known as 'PROTRACTOR'. On the protractor, the numbers are marked from 0^0 to 180^0 from both sides. These are the measures of angles depending upon which angle we are going to measures.





Suppose we want to find the angle between the lines AB and CD. There are to angles between the lines AB and CD. There are two angles between these lines 1 and 2. We put the midpoint at C and start reading from that direction which reads from 0 towards B, then find where CD coincides with the angle on the protractor. This is the required angle. This is known as acute angle since it is less than 90^0. Suppose we want to measure < ACD (No 2) then we read in that direction which points 0 towards A. This angle you measure is known as obtuse angle, it is more than 90^0 but less than 180^0. Now add the two angles, what do you get? 180^0. Can you remember the name of this angle? 2 right angles, half revolution or straight line angle. Angles 1 and 2 are known as 'SUPPLEMENTARY ANGLES. So 1 is a supplementary of 2 and vice-versa.

Activity No 3: - In navigation, it is often necessary to find the position of a place from a given place, suppose we are at P and want to know the location of Q. We have learnt that one way is to find the horizontal and vertical distance. But in navigation and maps it is not possible so we draw the directions line at P and join PQ. Measure <NPQ this is the angle which will give the location of Q. This angle is known as 'BEARING'. We say bearing of Q from P is b^0. See carefully that we always measure angle from North direction from the point where we have to find the bearing. What if we want to find the bearing of P from Q, measure the P marked angle. This will be the bearing of P from Q.



- JOS
- KADUN
- LAGOS
- WARRI

Now do the following

Use your protractor to measure the bearing of

i) Jos from Kaduna ii) Lagos from Jos iii) Warri from Kaduna

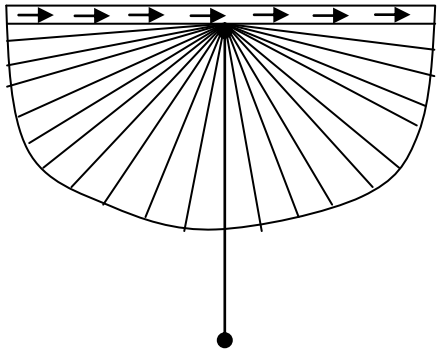
Lesson 3: - Angle of Elevation

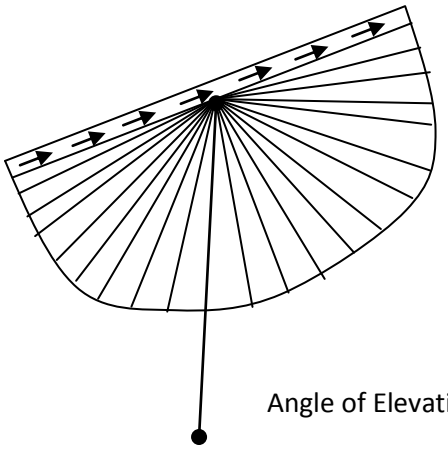
Materials required: - Astrolabe (Black board Protractor) and tape

Angle of elevation and depression can be measured with a simple instrument called Astrolabe: - Astrolabe is an instrument used commonly in ancient and medieval astronomy to find the angular distances of stars and planets.

Students' Activity: - Each student to make an astrolabe from a chart paper cut into a semi-circle of about 5cm in radius. A divider or a pair of scissors can be use to cut the chart paper in the form of a semi-circle. Mark the angles from 0^0 to 180^0 on the semi-circle similar to the markings on a protractor. Roll a rectangle piece of chart paper into a hollow tube and stick it with a cello tape to prevent it from unrolling. Attach the paper-tube along the diameter of the semi-circle from the centre of the circle which is also a hollow tube suspend a plumb line (bob tied to the string) as in the figure below.

ASTROLABE





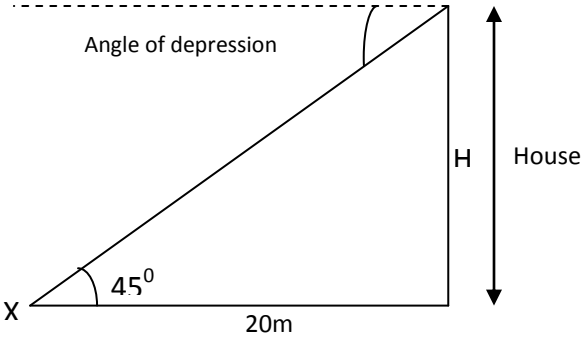
Angle of Elevation

To find the angle of elevation of a tall object. Look through the tube at the top of the object. The angle made by the plumb line with the 90^0 line on the semi-circle is the angle of elevation of the object. If this angle is α (alpha) then height of the object above eye level can be obtained by multiplying the distance of the object by tan α.

Class Activities:

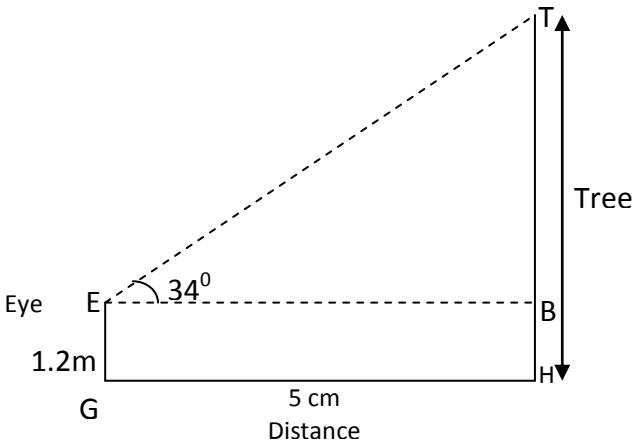
Student to pair themselves, that is student to group themselves in twos and carry out the following activities.

1) Stand at a point X on level ground where the top of the highest building in the school has an angle of elevation of 45^0, using a tape measure; find the distance from X to the base of the building record the height of the building.
2) Use an astrolabe to find the angle of elevation of the top of a tree measure the distance of the tree from the observer and the height of the observer's eye above the ground. Hence find the height of the tree.



Height of the building = 20m x tan 45^0

H= 20 x tan 45^0



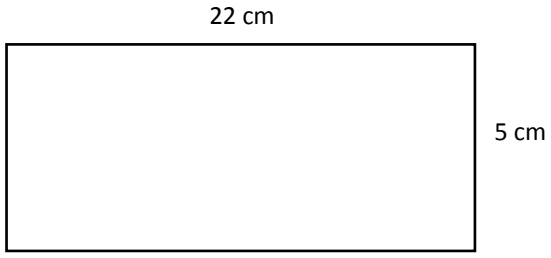
The height of the tree will be BT + BH

Students are to know that there is a connection between angle of elevation and depression. They are alternative angles

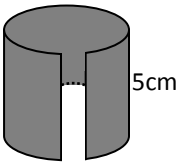
Lesson 4: - Surface area of a Cylinder

Materials: - Cylindrical tins of different sizes, Cardboard paper, scissors, ruler and a chalkboard

Class Activities: - Each students to cut a strip of cardboard paper 5cm wide by 22m long as shown below.



Roll the paper to make a cylindrical surface as shown below.



a) What is the height of the cylinder? (5cm)

b) What is the circumference of each circle at the open ends of the cylinder? (22cm).

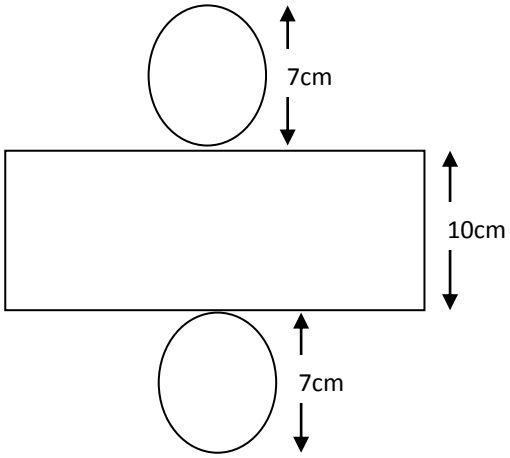
c) Calculate the area of the rectangle you cut out area of the rectangle = L x W = (22cm x 5cm = 110cm^2)

d) Does this area change when the rectangle is rolled into a cylinder? (No)

e) Measure to the nearest cm, the diameter of one of the circle at the open end of the cylinder. Use this value to calculate the circumference of the circle. Does your answer agree with your answer to part b? (Yes).

This type of cylinder that you have just made is open at the top end bottom.

Activity 2: - The teacher sketches the net of a cylinder on the chalkboard as shown below.



a) What will be the height of the cylinder? (10cm)

b) What is the diameter of the circular face of the cylinder? (7cm)

c) Calculate the circumference of each circle. (22cm).

d) Hence, write down the length of the rectangle. (22cm)

e) Make an accurate full size drawing of the figure on the chalkboard on thin cardboard. Cut the net out into the shape of a cylinder.

Now, how many parts has a cylinder? (3)

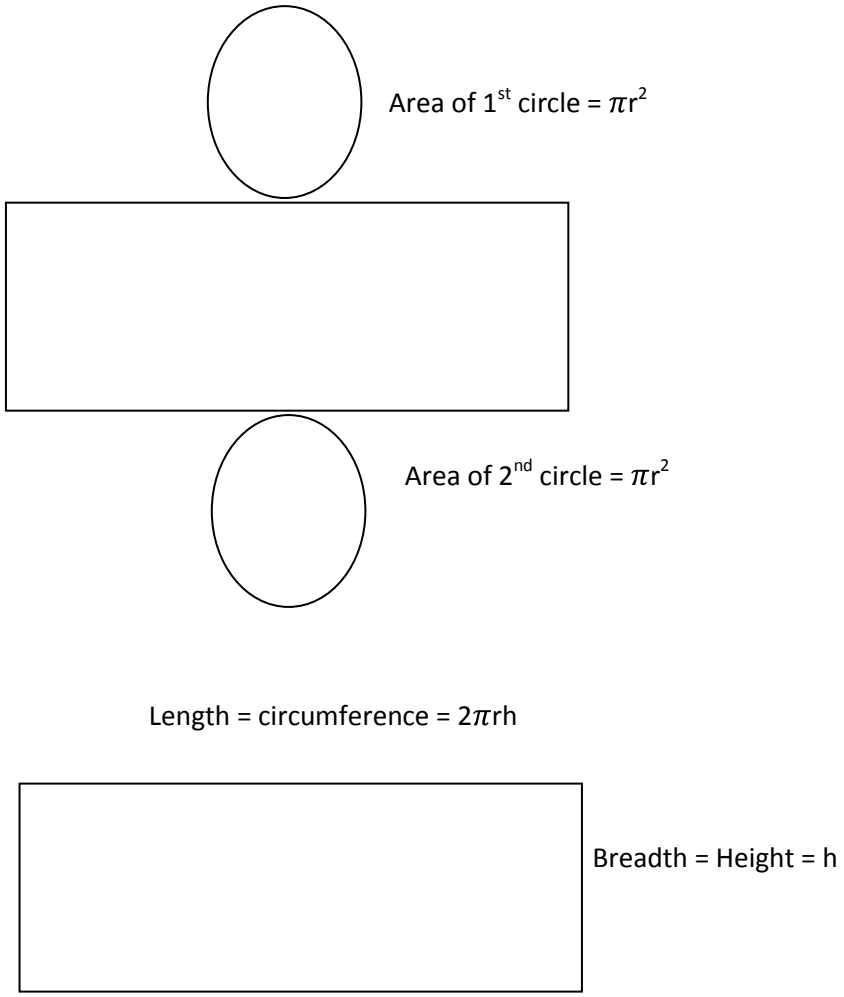
Mention the parts i.e. 2 circular part and one (1) rectangular part.

What side of the rectangle equals to the circumference of the circular part of cylinder? (Length)

What side of the rectangle gives the height of the cylinder? (breadth or width).

What is the name of the part that form the curve surface of a cylinder? (Rectangle).

What is the total surface area of a cylinder? The net of a cylinder is made up of two circles and a rectangle. The total surface area of cylinder will be the total areas of the two circles and area of the rectangle.



Area of rectangle = Length x breadth

$= 2\pi r \times h$

Area of curved surface = $2\pi rh$

Total surface Area of closed cylinder equals

$\pi r^2 + \pi r^2 + 2\pi rh$

$2\pi r^2 + 2\pi rh$

With the above activities students were able to discovered total surface area of closed cylinder without any stress.

APPENDIX F

20 items attitude towards Mathematics as answered by both the Experimental and control students were tabulated indicating their frequencies of response of Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree including their mean responses and Standard deviations.

Mean and Standard Deviation of Experimental and Control Groups

S/N	ITEMS	Location	Response categories					Mean	Mean Diff.
			SA	A	UD	DS	SD		
1	Geometry is dull and boring	Exp	30	81	18	9	12	3.94	.95
		Control	39	83	8	5	5	2.91	.89
2	When I hearthe word Geometry I have feeling of dislike	Exp	8	49	21	57	15	3.09	1.04
		Control	5	47	5	19	14	3.07	1.01
3	Geometry is fascinating and fun	Exp	55	46	3	24	22	2.36	1.22
		Control	14	24	5	55	45	2.21	1.06
4	I am happy in a Geometry lesson than in any other lesson	Exp	58	45	6	23	18	2.99	1.34
		Control	22	17	5	54	42	2.49	1.12
5	Geometry is very interesting to me and I enjoy studying Geometry	Exp	73	50	8	10	9	2.26	.87
		Control	3	8	40	52	37	2.02	.65
6	I do not like Geometry and it scares me to take it	Exp	27	41	20	34	28	3.40	1.22
		Control	40	45	41	5	9	3.34	1.02
7	I am able to solve Geometry problem without too much difficulty	Exp	39	48	13	27	23	3.15	1.39
		Control	8	5	10	69	48	1.97	1.04
8	I am always under a terrible strain in a Geometry lesson	Exp	20	14	11	68	37	3.90	1.07
		Control	28	86	16	4	6	3.48	.90
9	Geometry is something I	Exp	41	41	31	18	19	2.85	1.19

	enjoy a great deal	Control	4	29	24	46	37	2.64	.98
10	I fear to read Geometry because it involves cramming formulae	Exp	20	45	3	53	29	2.83	1.39
		Control	57	24	4	46	7	2.09	1.17
11	I do not like Geometry	Exp	44	30	34	32	10	3.44	1.42
	because I don't need it	Control	32	39	5	47	17	3.16	1.29
12	Knowing too much of Geometry can be dangerous	Exp	11	8	22	59	50	3.94	1.24
		Control	38	29	41	21	14	2.77	1.15
13	Attending Geometry class is a waste of time	Exp	21	23	25	46	35	2.66	1.36
		Control	21	45	40	19	15	3.27	1.19
14	Only brilliant students can understand Geometry	Exp	48	38	14	5	5	4.06	.92
		Control	55	48	4	9	24	3.16	1.63
15	I prefer to work in Geometry related environment	Exp	57	49	8	21	15	3.49	1.07
		Control	20	12	10	61	37	3.09	1.04
16	I have difficulty in understanding the language used in teaching geometry	Exp	23	33	7	54	33	3.01	1.44
		Control	53	37	29	12	9	3.81	1.22
17	I do not understand angles, bearings and area of cylinders	Exp	23	18	6	58	45	2.82	1.41
		Control	44	43	20	18	15	2.68	1.34
18	Our mathematics teacher uses clock, tins, thread,tape in teaching geometry	Exp	74	56	0	12	10	2.94	1.42
		Control	0	5	15	54	66	3.74	1.26
19	Geometry is the worst topic I hate in mathematics	Exp	13	10	28	37	66	3.69	1.41
		Control	51	46	32	2	9	3.29	1.14
20	Geometry has many technical terms that are difficult to remember	Exp	12	9	7	87	35	4.19	1.31
		Control	44	40	16	16	24	2.71	1.21

Ranks

	Group	N	MeanRank	Sum of Ranks
Attitude	Experimental	150	165.56	24834.00
	Control	140	124.01	12361.00
	Total	**290**		

MANN-WHITNEY U-test

Test statistics

	Attitude
Mann-Whitney U	197.500
Z	4.22
Asyp Sig. (2-tailed)	0.000

APPENDIX G

LESSON PLAN FOR CONTROL GROUP

WEEK 1

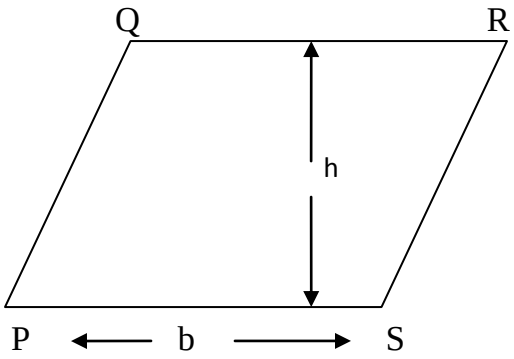
Name of Study Schools: Government Secondary School, Yakase and Government Secondary School, Giwa
Name of Researcher: Alake Esther
Class: JS 2
Gender: Male and Female
No of Students: 140
Average age: 13 years
Subject: Mathematics
Topic: Area of parallelogram
Duration: 80 min/week
Previous Knowledge: Students have Been taught plane shapes
Objective: At the end of the lesson the students should be able to:

- Find the area of parallelogram
- Find the base of parallelogram
- Find the height of parallelogram

Instructional aids Regular and irregular cardboard shapes
Introduction Teacher introduces the lesson by asking the following questions

i. What is plane shapes
ii. Mention all the plane shapes you know
iii. What is the difference between a parallelogram and a trapezium

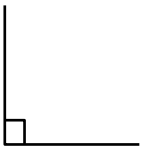
Presentation: The teacher presents the lesson as follows:
Step 1: Teacher draws a parallelogramon the chalkboard



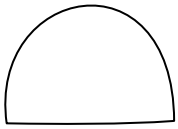
Step 2:	Teacher write the formula of area of parallelogram drawn In the diagram, the height of the parallelogram is h and its base is base in general: Area of parallelogram = base x height and base ofparallelogram = area ÷ height height of parallelogram = area ÷ base
Step 3:	Teacher solve some examples on area of parallelogram In the parallelogram drawn If b = 2cm h = 1cm Area of parallelogram PQRS = 2cm x 1cm = $2cm^2$ **Examples 2** The area of a parallelogram is 99cm2 and its base is 11cm calculate the corresponding height of the parallelogram Height of parallelogram = $99cm^2$ ÷ 11cm = 9cm
Students activity:	Students listen and answer questions, solve along with the teacher some students to solve some questions on the chalkboard.
Evaluation:	The teacher evaluates the students with class work and goes round to monitor their performance
Conclusion:	The teacher concludes the lesson by working out corrections and made the students to write down corrections in their notebook.

LESSON PLAN FOR CONTROL GROUP

WEEK 2

Name of Study Schools:	Government Secondary School, Yakase and Government Secondary School, Giwa
Name of Researcher:	Alake Esther
Class:	JS 2
Gender:	Male and Female
No of Students:	140
Average age:	13 years
Subjects:	Mathematics
Topic:	Angle
Duration:	80 min/week
Previous Knowledge:	Students had learnt about Construction of angles.
Objectives:	At the end of the lesson the students should be able to: • Explain what an angle is and its unit of measurement; • Identify different types of angles; • Solve problem on angles
Instructional Aids:	Blackboard, Ruler and Protractor, cardboard showing angles from 0^0 to 360^0
Introduction	The teacher introduces the lesson stating that angle is amount of rotation or amount of turning. The unit of measuring angle is known as degrees and protractor is instrument used for measuring angles. Teacher explain clockwise and anticlockwise turning.
Presentation	
Step 1:	Teacher mention and writes types of angles such as angle 90^0 known as right angle, angle on a straight line known angle 180^0or half a revolution and angle at a point known as 360^0 or one revolution
Step 2	Teacher leads the students to learn and copy down the definition of angles, units of angles, different types of angles including complimentary angles on their notebooks; different types of angles are drawn and shown to the students like a) 

b) angle 180^0 or angle on a straight line etc



students will be asked different kinds of questions like:

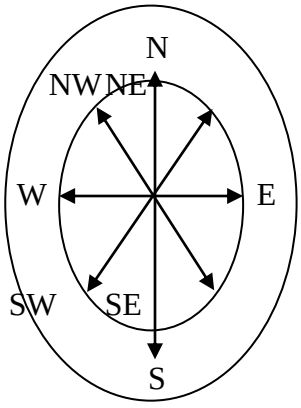
a) What is a complimentary angle?
b) What is 1 revolution?
c) What is anticlockwise turning

Conclusion: Teacher concludes the lesson by giving assignment to students.

LESSON PLAN FOR CONTROL GROUP

WEEK 3

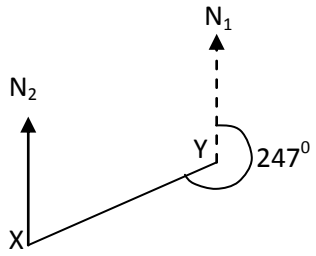
Name of Study Schools:	Government Secondary School, Yakase and Government Secondary School, Giwa
Name of Researcher:	Alake Esther
Class:	JS 2
Gender:	Male and Female
No of Students:	140
Average age:	13 years
Subject:	Mathematics
Topic:	Bearing and Distances
Duration:	80 min/week
Previous Knowledge:	Students had learnt about angles, knowing about anti-clockwise and clockwise direction. They have been taught alternate and corresponding angles.
Objective:	At the end of the lesson the students should be able to: • State and find bearings of points from each other.
Instructional aids:	Magnetic compass drawn on a cardboard paper and chalkboard instruments
Introduction	Teacher introduces the lesson by reminding the students' about minor and major cardinal directions. There are four main directions: north (N) south (S) east (E)and west (w). Apart from the four main points or directions, there are also four secondary directions; north east (NE) south east (SE), south west (SW) and north west (NW).
Presentation **Step 1:**	Teacher draws the compass and show the main points of the compass



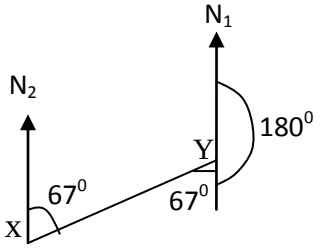
The angle between the direction north and east is 90^0, N and E is the direction midway between N and E. thus the angle between N and NE is 45^0.

Step 2: Teacher solve some examples:

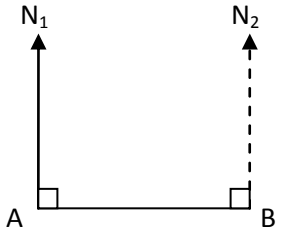
i. If bearing of x from y is 247^0find the bearing of y from x



N_2XY is the bearing of Y from X



Moving clockwise direction from the north
The bearing of Y from X is 67^0[alternate angle]
Example 2: - In the Figure below calculate
i) the bearing of A from B;
ii) the bearing of B from A.



The bearing of A from B is 270^0; the bearing of B from A is 90^0.

Evaluation: Students listen and answer questions, solve along with the teacher, also solve the class work given to them.

Conclusion: The teacher gives correction at the end of the class.

LESSON PLAN FOR CONTROL GROUP

WEEK 4

Name of Study Schools:	Government Secondary School, Yakase and Government Secondary School, Giwa
Name of Researcher:	Alake Esther
Class:	JS 2
Gender:	Male and Female
No of Students:	140
Average age:	13 years
Subjects:	Mathematics
Topic:	Angle of Elevation and Depression
Duration:	80 min/week
Previous knowledge:	Students have been taught alternate angles they hadlearnt about scale drawing

Objectives:

At the end of the lesson the students should be able to:

- Determine angles of elevation of points above the horizontal;
- Determine angles of depression of points below the horizontal;
- Use measurement of angle of elevation and depression and scale drawing to find height and distance

Instructional Aids: Chalkboard instruments

Introduction

Teacher introduces the lesson with following questions

i. Angles on a straight line is angle _____
   Expected answer 180^0
ii. Alternate angles are _____
   Expected answer equal

Presentation

Step 1:

Teacher gives explanationon horizontal and vertical surface. Any surface which is parallel to the surface of the earth is said to be horizontal e.g. the floor of your classroom is horizontal also the top of a table can be said to be horizontal plane. Any line of surface which is perpendicular to the horizontal surface is said to be vertical e.g. the legs of a table can said to be vertical to

the ground.

Step2:

An observer has to raise or elevate his head to view the top of any objectwhich is taller or higher than him e.g. a tree. The amount of turning made by the head from the horizontal position is called the angle of elevation at the top of the object from the observer. From a raised platform we can view objectwhich are below use.g. of such raised platform a story building. When an observer on a raised platform looks down at an object below him. The observer has to lower or depress his head in other to look down. The amount of turning made by the head from the horizontal position is called the angle of depression of the objectfrom the observer.

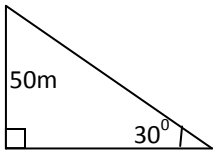
Step 3:

Teacher solve examples on angles of elevation and depression using scale drawing

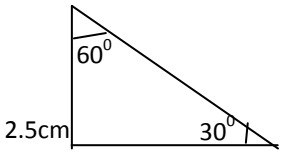
a) The angle of elevation of the top of a tower from the observer on the ground is 30^0, if the tower is 50m high. How far is the observer from the foot of the tower?
Scale 1cm = 20m

Instructional Procedure:

Rough sketch



Scale drawing



From the scale drawing the distance of the observer from the foot of the tower is 87m.

Students activity:

The students participate in finding angle of elevation and depression using scale drawing with their ruler and protractor solving along with the teacher then, solve the questions given to them on their notebook.

Evaluation: The teacher evaluates the students with class work, she moves round the class to monitor their performance.

Conclusion: The teacher worked out corrections.

LESSON PLAN FOR CONTROL GROUP

WEEK 5

Name of Study Schools:	Government Secondary School, Yakase and Government Secondary School, Giwa
Name of Researcher:	Alake Esther
Class:	JS 2
Gender:	Male and Female
No of Students:	140
Average age:	13 years
Subjects:	Mathematics
Topic:	Area of a Cylinder
Duration:	80 min/week
Previous knowledge:	The students have been taught area of a rectangle, they can also find area of a circle.

Objective: At the end of the lesson the students should be able to:

- Calculate the surface areas, uniform cross sectional area and the total surface area of a cylinder.

Instructional Aids: Chalkboard instruments

Previous Knowledge: Teacher introduces thelessonby asking the following questions:

i. What is the difference between plane shapes and solids
ii. What is theformulafor finding the area of a circle
iii. Mention all the solids and plane shapes that you know

Presentation

Step 1: The cylinder is a solid with two circular surfaces and one curved surface. Teacher write formulae for the students to copy and use

For a cylinder of radius r and height h

Area of curved surface = $2\pi rh$

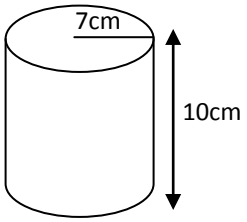
Total surface area of closed cylinder = $2\pi r^2 + 2\pi rh$

$\pi = 3.14$ or $\frac{22}{7}$

Step 2:

The teacher solves some examples on the chalkboard for students to copy on their notebooks.

a) Calculate the curved surface area of the cylinder shown below?



Curved surface area = $2\pi rh$

$= 2 \times \frac{22}{7} \times \frac{7}{1} \times \frac{10}{1} = 440cm^2$

b) What is the height of a cylinder whose curved surface area is 176cm?

$2\pi rh = 176$

$i.e\ 2 \times \frac{22}{7} \times h = 176$

$\frac{176h}{7} = 176$

$h = 176 \times \frac{7}{176}$

$\therefore h = 7cm$

Students activity:

Students listen and solve along with the teacher. They solve example (C) in their notebooks.

Calculate the total surface area of a cylinder of radius 28cm and height 10cm.

Evaluation:

Teacher calls students in turn to solve some questions on the chalkboard.

Conclusion:

The teacher gives correction at the end.

WEEK 6

This week is dedicated to revision and administration of instrument Geometry Achievement Test (GAT).

For the period of six weeks, two classes of control group were taught the same topics as in experimental groupduring their normal lesson involving four contactsof 80 minutes per week. To this group, their teachers taught them with only lesson plan provided by the researcher. At the end of six weeks teaching period the mathematics achievement test was administered to the control group before and after six weeks of teaching. The different scores obtained during pretest, posttest and post-posttest were used for data analysis