EFFECT OF GUIDED DISCOVERY AND GRAPHICAL APPROACHES ON MATHEMATICS ACHIEVEMENT AND ATTITUDE OF SENIOR SECONDARY SCHOOL STUDENTS IN MINNA, METROPOLIS, NIGERIA

BY

NDABA, David Sule
MTech/SSTE/2017/7226

DEPARTMENT OF SCIENCE EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA

OCTOBER, 2021

EFFECT OF GUIDED DISCOVERY AND GRAPHICAL APPROACHES ON MATHEMATICS ACHIEVEMENT AND ATTITUDE OF SENIOR SECONDARY SCHOOL STUDENTS IN MINNA, METROPOLIS, NIGERIA

BY

NDABA, David Sule
MTech/SSTE/2017/7226

**A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD
OF MASTER OF TECHNOLOGY (MTech) IN MATHEMATICS EDUCATION**

OCTOBER, 2021

ABSTRACT

This study examined the Impact of guided discovery and graphical approaches on mathematics achievement and attitude of senior secondary school students in Minna, Metropolis. Relevant literature were also reviewed inline with the objectives of the study. Quasi-experimental design precisely, pre-test, posttest, non-equivalent control group was adopted for the study. The target population for this study consists of three thousand nine hundred and ninety-nine (3,999) senior secondary school students II in Minna, Metropolis (Male=1641, Female=2358) in 2020/2021 academic session from 3 public senior secondary schools in Minna metropolis of Niger State. The sample for this study consists of 110 students and simple random sampling technique was employed in the selection of the schools. Two instruments were adapted for the study which consists of Mathematics Achievement Test (MAT) and Mathematics Attitude Rating Scale (MARS). Descriptive statistics (mean and Standard Deviation) method was used to answer the research questions and ANOVA and t-test were used to analyze the hypothesis at 0.05 level of significance. The instruments were validated by expert and the reliability coefficient was 0.90 and 0.88 for MAT and MARS respectively. The findings of the study revealed that students performed better in the experimental group (guided discovery method and graphical approach) than the control group using conventional method of teaching with mean gain of 31.43 and 32.00 against 29.49. The result also showed that the students have developed positive attitude towards mathematics after teaching using graphical approach. Recommendations included among others that; Mathematics teachers should endeavor to use the graphical approach teaching strategy in teaching equations both linear and quadratic and some other Mathematics concepts that are tagged "difficult" since this method enhances achievement and has the potentials of developing critical thinking and creative abilities in the students and Students should be serious, hardworking, initiative and creative to enable them carryout independent or group work, such as assignments or project given to them by the mathematics teachers among others

TABLE OF CONTENTS

Content **Page**

LIST OF TABLES

LIST OF FIGURE

LIST OF APPENDICES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Mathematics is a subject that affects every aspect of human life at different levels. Mathematics is seen by the society as the foundation of all sciences, technology and modern development, and for any nation to survive and develop, that nation has to improve its technology which could be achieved through the effective teaching and learning of mathematics (Agwagah & Gimba, 2013). Mathematics is a science of magnitude and number that is very useful virtually in all subject areas. This is because all fields of studies are dependent on it for problem solving and prediction of outcomes. Competency in mathematics learning is vital to any individual and nation in domestic and business deals, scientific discoveries, technological breakthrough, problem-solving and decision making in different situations in life. Akinoso (2013) viewed mathematics as the basis for science and technology and the tool for achieving scientific and technological development. It may be in consideration of these and other vital usefulness of mathematics that Federal Government of Nigeria made it a core and compulsory subject at all the levels of 6-3-3 system of education in Nigeria as contained in the Federal Republic of Nigeria (FRN, 2013) which still remains the rallying point for all educational objectives in Nigeria. Despite its great importance mathematics still remains the most feared subject by learners.

Mathematics is tagged by students most especially in secondary level of education has the most dreaded among all subjects offered in schools (Akinoso, 2013). Students therefore tend to respond to it with less self-confidence, negative feeling and anxiety. This situation is worsened by the compulsory nature of the subject at primary and post primary schools levels, leading to students' poor achievement in the subject (Nguyen *et al.*, 2019).

The incessant poor achievement in mathematics in Nigeria Secondary Schools levels may be attributed to poor method of teaching, unavailability of facilities and lack of instructional materials. Students' lack of interest in learning mathematics. Interest has to do with preparedness or mastery of a subject –matter background knowledge that can enable the learner to cope with further or next higher level of learning of the subject-matter or related learning task (Idigo, 2010). This suggests that mathematics interest test for senior secondary level has to do with mastering the prerequisite skills in junior secondary school (JSS) level mathematics that can enable the JSS three students cope with further learning of mathematics at the next higher level of mathematics teaching in senior secondary school one (SSI) level. And mathematics interest test can be developed and used as an indicator of success in any mathematics course (Idigo, 2010; Goolsby, 2013). Many factors have been identified in literature as reasons associated with students' lack of interest in learning mathematics. These include Students' factor, teachers' factor, mathematics anxiety, class size, government factor, infrastructural problem, instructional strategy, among others (Akinoso, 2013; Goolsby, 2013). Students' factors are caused partly by mathematics phobia and fear that mathematics is a difficult subject as perceived by the researcher during the process of teaching mathematics. These have led to students' inability to practice and learn to solve mathematical problems on their own, which invariably lead to poor academic achievement in mathematics.

Poor achievement in mathematics can be attributed to many factors such as: poor method of teaching. Unavailability of laboratory facilities and lack of instructional materials. Mastery of mathematics concept might not be fully achieved without the use of good instructional materials. West African Examination Council (WAEC) Chief Examiner report (2008-2017) the pass rate at credit level recorded for 2008-2017 are 57.28%, 47.04%, 41.95%, 40.35%, 50.58%, 54.18%, 61.97%, 57.02%, 70.23%, 82.35%. Even through there has been some improvement in the students' performance particularly in 2016 and 2017 but it has to be sustained as inadequate teaching and learning materials pose a great challenge to the primary education resulting in poor performance in mathematics (Akinoso, 2013).

Achievement according to Bolaji (2015) is the scholastic standing of a student at a given moment. It has to do with the successful accomplishment of goal(s). The purpose of testing an achievement is to help the teacher and the students evaluate and estimate the degree of success attained in learning a given concept. It is also useful in testing the retention of information and skill. It is equally appropriate in determining the efficiency of instruction. One of the issues at stake in education today is students' achievement measure in relation to teaching and the overall success of learning outcome, Use of guided inquiry teaching method in teaching simple machine by basic science teachers may make Basic science lesson objective stimulating and interesting to the students learning attitude (Ukamaka, 2014).

Attitude is generally a positive or a negative view of a person, place, thing, or event. It influences every aspect of a person's life either positively or negatively. Students' ability and willingness to learn depends on the attitude. Attitude is an effective variable that that can affect learning negatively if the factors driving the attitude are not properly checked (Eze, 2015). Attitude has been seen as a hypothetical construct that represents an individual's degree of like or dislike for something. Supporting this Oba and

Aladejana (2014), using schema theory, observed that children and adolescents use gender to classify and understand their attitude about the world. A more effective learning will be the result and this will bring about realization of the goal of Nigerian education as stated in the National Policy on Education (Oche, 2012). An approach of instruct through which students interact with their environment by exploring and manipulating object is regarded as guided discovery learning.

Guided discovery learning using the form Super item task, besides directing students to discover concepts, rules, and procedures. It can help train the students' in terms of problem-solving, ability that can be used optimally and ultimately to improve student learning outcomes. Students work on simple problems then move to more complex tasks. This process can optimize the application of mathematical problem-solving skills and accelerate students' understanding of a concept, which will ultimately be a positive influence on student learning outcomes (Maikudi, 2015). Factors responsible for the poor performance according to Ale et al. have been traced to lack of appropriate instructional materials for teaching the concept. Such instructional materials include graph, and so many others (Nwoye, 2011).

The use of graph has provided a great deal of opportunity to teach some difficult concepts in mathematics at primary school level in particular. According to Ohuche (2010), the use of graph has been very successful for the teaching of some concepts in mathematics that are very difficult. These concepts, continued include-area, fraction and proportion. This is because, graph tend to be quicker in conveying the required information. The nature of graph makes it very easy to use for the illustration of information. For instance, a graph page is made of several square units along several rows and columns. These features made the use of graph for teaching concepts like area, and population very easy and interesting. Adegoke *et al.* (2015)

reported that students' positive attitude improve students' academic performance in mathematics in secondary schools and gender was not significant.

The issues of gender on students' academic performance in mathematics have become the global debate. Gender refers to the social meanings associated with being a male or a female, including the construction of identities, expectations, behaviours and power relationships that derive from social interactions.

Based on the above attributes, the researcher intends to assess the impact guided discovery and graphical symbol approach on mathematics achievement and attitude of senior secondary school student in Minna.

1.2 Statement of the Research Problem

It is the researcher's observation and experience over the past 20 years of teaching that students seem to assume that mathematics has no relevance in day to days living. For this purpose those doing well in it at lower level of education, suddenly decline on getting to higher level of studies. A teacher came in contact with 11 year old girl while teaching in a secondary school. The girl asked him, what he intended to further his education with? And the teacher replied "mathematics". On hearing this, she shouted "mathematics!" The acclamation did not just come to her, but resulted from the aversion she has for mathematics. It is possible that this aversion was created in her by the parents, peer groups, or poor handling of the subject by her teacher. That might have given her the impression that mathematics is not a subject to further with. The aversion affected the girl's performance from her usual 2nd or 3rd position in mathematics class, but found her-self in position 15th and above. The researcher believed that, "Many students fail mathematics not because they cannot make it, but because of aversion".

While this is hampering the success of the students, it will be very unfortunate for potential mathematicians to refuse practicing mathematics. Odeyemi (2015) said that many students failed mathematics examination as a result of negative attitude towards mathematics, the results obtained in mathematics by students in both schools and public examinations as pointed out by Emah (2015), is so alarming. Obanya (2012), said that the attitudes exhibited by many people especially students and adults in the society towards mathematics need special attention for the young developing nation desirous to practicing scientific technology and industrial developments.

Studies have showed that high achievement in mathematics is related to low mathematics aversion level and low achievement in mathematics is related to high mathematics aversion level for secondary school student (Bello, 2011).

Furthermore, Yaako and Okoro (2019) observed that students overall performance in secondary school Mathematics placement Exam conducted annually has generally been very poor and that students rarely or sometimes completely avoid attempting some technical questions in geometry. This failure rate may be due to poor method of teaching by some teachers which resulted to negative attitude by some students and lack of good instructional materials that could stimulate the interest of students which may lead to better understanding of the subject. Hence there is the need to develop a strategy that might enhance students' active participation, positive attitude and high academic performance in mathematics such as the guided-discovery and graphical symbols at senior secondary schools. This study therefore assess the effect of guided discovery and graphical method on mathematics achievement attitude of secondary school students.

1.3 Aim and Objectives of the Study

The aim of the study is to determine the effect of discovery and graphical approach on students' achievement and attitude in Mathematics among senior secondary school in Minna metropolis.

The specific objectives of the study are to.

1. Examine the difference in the mean achievement of senior secondary school students taught Mathematics using guided discovery, graphical approach and conventional method in Minna metropolis
2. Determine the difference in the mean achievement of Male and Female students taught Mathematics using guided discovery method
3. Identify the difference in the mean achievement of Male and Female students taught Mathematics using graphical approach.
4. Find out the difference in the attitude of secondary school students taught Mathematics using guided discovery, graphical approach and conventional method
5. Investigate the attitude of Male and Female senior secondary school students to Mathematics after taught with guided discovery method
6. Determine the attitude of Male and Female senior secondary school students to Mathematics after taught with graphical approach

1.4 Research Questions

The following research questions were raised as a guide to carry out the study.

1. What is the mean achievement scores of students taught Mathematics using guide discovery method and graphical approach and conventional method?
2. What is the mean achievement scores of Male and Female students' taught Mathematics using guided discovery method?

3. What is the mean achievement scores of Male and Female students taught Mathematics using graphical approach?
4. What is the attitude of senior secondary school students toward the use of guided discovery method, graphical approach and conventional method?
5. What is the attitude of Male and Female senior secondary school students to mathematics after taught with the guided discovery method?
6. What is the attitude of Male and Female senior secondary school students to mathematics after taught with the graphical approach?

1.5 Research Hypotheses

The following null hypotheses were formulated to guide the study:

HO_1: There is no significant difference between the mean achievement scores of students taught Mathematics using guided discovery method, graphical approach and conventional method.

HO_2: There is no significant difference between the mean achievement scores of Male and Female students taught Mathematics using guided discovery method.

HO_3: There is no significant difference between the mean achievement scores of Male and Female students taught Mathematics using graphical approach.

HO_4: There is no significant difference amongst the attitude of students taught Mathematics using guided discovery method, graphical approach and conventional method.

HO_5: There is no significant difference amongst the attitude of male and female senior secondary school student taught guided discovery method.

HO_6: There is no significant difference between the attitude of Male and Female senior secondary school student taught with graphical approach.

1.6 Significance of the Study

The findings of the study would be significant beneficial to mathematics teachers, students, curriculum planners, instructional materials designers and developers, Ministry of Education, National Examination Bodies, and the nation at large.

The result is expected to be useful to students of mathematics because it will provide opportunities for students to practice basic mathematical skills, particularly in mathematics. They would learn some basic concepts on their own at their own pace and time.

The study may be of benefit to mathematics teachers, most especially to mathematics teacher who would serve as the research assistance, because the guided discovery and graphical approach would stimulate, encourage and they would also pass their experience to other mathematics teachers too. It is hoped that the use of discovery and graphical approach would enable the teachers of mathematics to cover a wide range of topics within a short period of time without the teacher going through much stress. It would help teachers to arrange learning tasks from simple to complex.

The study could assist the curriculum planners to include in the curriculum for secondary schools method of teaching that would help in bringing about meaningful learning. This is to give direction and confidence to the teacher whose job is to put the curriculum into use and to ensure the attainment of specific objectives of learning mathematics.

The findings would help the Niger State Ministry of Education, Secondary Schools Board and all the stakeholders particularly the National Examination Bodies, such as the West African Examination Council (WAEC), National Examination Council

(NECO), National Teachers Institute (NTI), the National Mathematics Centre, Abuja (NMCA) and professional bodies such as the Mathematics Association of Nigeria (MAN), the Science Teachers Association of Nigeria (STAN) to plan policies that will involve the use of discovery learning and graphical approach for teaching and learning of mathematics in secondary schools, so that the desired goals and objectives of teaching the subject would be achieved.

1.7 Scope of the Study

The geographical scope is co-educational secondary schools in Minna metropolis, Niger state. Three independent variables (guided discovery, graphical approach and the conventional lecture method), two dependent variables (achievement and attitude) were investigated in this study. The study was restricted to SS II mathematics students. This class of students were chosen because the concept 'quadratic equation' selected as a topic is taught at this class. Quadratic equation is selected because its relevance to the major variables of the study and also it is a course that could be easily taught via graphical approach. This is in line with the study of Lillias *et al.* (2020) that says graphs of quadratic functions have distinctive properties which can be used to help us identify points of interest about an equation. Whether inspecting the graph of a quadratic function or using an equation to draw the graph. The study will last for 10 weeks.

1.8 Operational Definition of Terms

The following terms were defined based on the way they are used in this study.

Achievement: this refers to the gain in knowledge of SS II students after being part of the learning process of mathematics using discovery and graphical approach

Attitude: this is the change in behavior, emotion and belief of SS II students after being taught mathematics using discovery and graphical approach.

Conventional Method: This is the old established techniques of teaching using chalk/marker and board which is teacher center

Graphical Approach: This involves the use teaching and learning of SS II student using graph to teach some difficult concepts in mathematics as it will increase their understanding positively and improve their learning outcomes.

Guided Discovery Method: This involves the teaching and learning of mathematics by SS II students using the form super item task, besides directing students to discover concepts, rules and procedure for problem solving also to improve students learning outcomes.

Mathematics: is the study of such topics as numbers (arithmetic and number theory), formulas and related structures (algebra), shapes and spaces in which they are contained (geometry), and quantities and their changes (calculus and analysis).

Effect: a change which is a result or consequence of an action or other cause

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

Guided Discovery, Graphical Approach and Conventional approach Model as shown in figure 2.1.

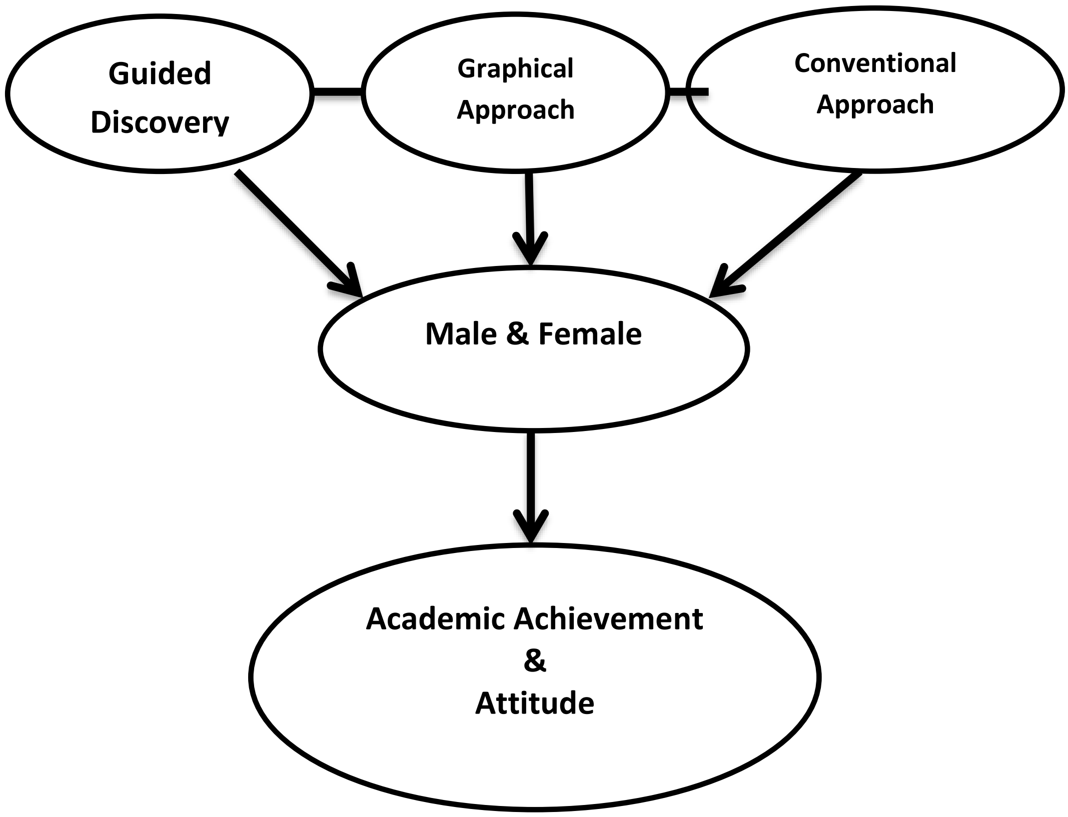

Figure 2.1: Conceptual framework

Source: Author's work (2021)

The arrows in figure 2.1 show a natural flow among the various components of the model. The effect of guided discovery approach will improve student academic achievement in mathematics. The effect of graphical approach will also improve student academic achievement in mathematics. The effect of conventional approach may also increased student academic achievement. The flow in the model will also change the attitude of the students positively in mathematics.

2.1.1 Concept of mathematics

Mathematics has been recognized as one of the subjects which is vital in people's life, be it in science, technology, business or in other walks of life. Mathematics play a fundamental role in scientific and technology progress of any nation and as such Mathematics is taught at all levels education (Ajai & Imoko, 2015). The authors further opined that greater demand for economic, scientific and technological knowledge in Nigerian development programme has brought about securing an excellent Mathematical knowledge at all levels of education. The main objective of teaching mathematics at secondary school level in Nigeria is to produce persons who will be numerate, orderly, logical, accurate and precise in thought. It is emphasized that certain content in the syllabus be covered, and specific concepts and skills be mastered by secondary school students. Four basic goals for teaching mathematics have been identified as: utilitarian, personal development, economic growth, and cultural values (Xia *et al.,* 2013; Yara & Otieno, 2010). Additionally, mathematics is used in all measurement activities, transport and communication manipulations, in management of organizations by preparing daily routines, timetables, and leave schedules. It is a requirement in many careers and trainings (Aguele & Agwagah, 2014). Furthermore, Baber (2011) observed that, mathematics is the gate and key of science. Neglecting mathematics wreaks injury to knowledge due to the relative difficulty of quantifying and manipulating nature and its myriad of manifested phenomena. It is an international language expressed clearly and with precision. It uses an internationally accepted symbol system that has condensed meaning and is understood by all (Gasca, 2011). Thus, it facilitates trade transaction across borders as units of quantification are understood universally. Mathematics is utilized in all cultural settings like patterning and timing of entertainment, construction of buildings, making of furniture, interior design, and decoration (Buschang *et al.,* 2011).

However, academic achievement in mathematics has continued to show a downward spiral over the years. Various researchers have identified factors that are believed to cause poor performance (Miheso, 2012). This includes: teachers not using student- centered approaches, lack of experiments and practical modeling activities, and lack of professional exposures that could have articulated issues related to teaching of mathematics in secondary schools. Many teachers attributed this performance to negative attitudes by the students as well as a missing link between primary and secondary school mathematics. Lack of application of technology including computer use, lack of parental support, and lack of motivation by both teachers and students were also noted. Eshiwani (2011) pointed out that poor performance in Kenya is due to poor teaching methods, and an acute shortage of textbooks. The fact that as many as six students would share one text book in some schools makes it impossible for them to complete both their class work and homework.

As such, the follow up teaching is not built on the students' homework experiences. This will invariably delay the pace at which the syllabus will be covered, leading to poor performance. Tswani (2015) found out that learners and teachers commitment and motivation, learners career prospects, learners perceptions of peers as well as teachers' perceptions of learners all affect persistence for achievement in mathematics. Overall, application of sound teaching and learning principles fosters an environment where pupils are motivated to achieve their full potential.

The issue of the technical language use in teaching mathematics has been cited as contributing to poor performance in the subject (Nor *et al.*, 2011). Wasike (2013) observes that poor performance is due to the difficult language used in the mathematics classroom. He says there are words which have a different meaning when used in common day English language compared to when they are used in mathematics.

Shikuku (2009) established that these factors do not directly contribute to poor performance in mathematics. Instead, late or non-coverage of the mathematics syllabus contributes a lot to poor performance.

2.1.2 Concept of mathematics teaching

Teaching mathematics can only be described as truly effective when it positively impacts student learning. We know that teaching practices can make a major difference to student outcomes, as well as what makes a difference in the classroom. Mbakwem and Mkpa (2013) referred to mathematics as a discipline that encourages curiosity, promote critical reasoning and active participation of learner. These objectives require instructional strategies that are activity base.

Audu (2015) in his presidential address said, in the era of technology quest and high attainment in modernization, no nation can allow his teaming population to shy away from mathematically related sciences. Audu (2011), took information technology as a useful delivery vehicle, to the right person, at the right manner and in the right place. Audu (2010) pointed out that information technological development is hinged on strong mathematics foundation. It is therefore not contend-able, that mathematics and mathematics sciences are indispensable. According to Badmus (2012) said that the effective and attitudinal variables that have been found to predict mathematics related behavior includes confidence in learning mathematics. As Badmus (2015) explained the need to pass to the students the willingness to apply scientific habits to a wide range of social content which includes multidimensional perspective about sciences and its relationship to other field of studies.

Eniayeju (2015) emphasize on the nation’s expectation of science’s contribution to life and further suggests the need to link between science literacy and national economy.

Etuk (2015) believed that the level of scientific cultural belief of students was scientifically high in spite the scientific knowledge they acquire at their level of education. For this reason, Ali (2010) suggests that the focus of scientific literacy should be on utilization of scientific knowledge for the benefit of the individuals learning to be a change of human disposal or capability that can be retained which is not ascribable to the process of growth, but can be described as the development of new knowledge, skills or attributes as individual undergoing learning interact with information and the environment such as the learning strategies or methods, the media and the physical facilities (Odili, 2015). Udoh (2012) said that self-estimated mathematics ability is found to be highly correlated with mathematics aversion and mathematics performance. That mathematics confidence and mathematics aversion have been found to be highly interdependent.

Badmus (2012) opined that the most important predictors of mathematics achievement when preparation (i.e. persistence in mathematics courses and election of future course of mathematics) are controlled by attitudes towards mathematics. Oganwu (2011) said that the meaning of individual learning is coupled with their life experience and contexts that are constructed by the learner not by teacher. The issue at hand is how to change the attitude of students and to attract their interest towards the practicing of mathematics.

Adetula and Ale (2015), suggests that, the extent students may be interested in mathematics class session, may depend on the Lesson’s objective. That lesson is designed to provide routine drill or mere memorization of mathematical facts may be less interesting than lesson whose goals are to stimulate thought or intellectual curiosity.

Harbor-peter (2011), conducted several studies, on students‟ attitude and interest towards mathematical science subjects, and concluded that, students manifested negative attitude towards mathematics and positive attitude towards what they called modern science teaching. Obioma (2012), explained that students do not find the study of physics boring like that of mathematics. Odili (2015), opinioned that, students‟ attitudes and interest are directly influenced by the personal quality of their teachers and the nature of classroom climate created.

Harbor-peters (2011) observed students‟ attitude to mathematical sciences and said, that students developed negative attitudes to mathematical sciences, which they attributed to the students‟ misconception of sciences. Adetula and Ale (2015), explained that, negative attitude inhabited students‟ understanding of the content of mathematics. Obodo (2015) said that students with positive attitude are more likely to study mathematics because they enjoys or like it. Because, he gets satisfied with acquiring mathematics ideas, he finds mathematics activities very rewarding. That student may likely work diligently and effectively on a task that they are genuinely interested in. Bature (2013) suggests the need to give students the right opportunity. That if aversion must be eradicated, positive attitude must be built in student been the learner.

What then is attitude and what is interest? Badmus (2015), took attitude to be the way one perceives, the opinion one holds as well as the belief one has about people, things, activities, institutions, policies, administrations and general phenomena. Bature (2013), view attitude as mental and natural state of readiness organized through experiences, exerting a directive or dynamic influence on individual’s response to all objects or situations with which it is associated. Adetula and Ale (2015), view interest as the feeling of intentness, concern or curiosity about an object. He said that interest leads individual to make variety of choices with respect to their activities in which he or she engages on.

Harbor-Peters (2011), see attitude and interests to be closely related, that they are just like abstract and concept. But the wider term is attitude, which subsumes interests.

Lawal *et al.* (2011), regarded Interests as attitudes that cause one to seek more activities in a particular area. He said that there are positive attitudes on a selected aspect of activities. On the other hand, there are negative attitudes that force one to refuse an activities offered by a selected aspect of an environment. A child through experience, imitation of admired adult or member of the group may have learnt to like or dislike mathematics. Gushen (2011), Agued, Attitudes are more than any form of learning. They are transformed through the processes of initiations and may have their origin early in life. Ganiyu (2015) said, that, some attitude spring from modeling behavior and identification within the peers in latter childhood and adolescence, others may spring up through parent's likeness as the case may be.

Watermeyer (2012), opined that attitudes has both perceptual and effective components. They determined not only what the child sees but how he sees it. A child can acquire certain attitude toward a subject through the influence of their parents, peer group or class teachers, which may lead them to respond to those mode of behavior that are characterized in a particular way of expressing dislike or defense. Badmus (2015) said that attitudes can resist changes once established. It is important to create a desirable attitude in learning mathematics at early stage of learning.

Druger (2012), Said, "Just as we can arrange for our children to acquire a particular information for particular skills, so we can arrange for them to acquire particular attitudes and interests. What is needed is for the teacher to understand the skills".

2.1.2.1 Strategies for teaching mathematics

Research has shown that teachers should help learners to develop positive attitude towards the Mathematics. This aids in the increase of interest in learning it (Obodo, 2012). The teacher should make the subject interesting and exciting enough through the methods that will be used. There are quite a number of strategies which can be used in the teaching of Mathematics. Student involvement is crucial in doing away with the problem of poor academic performance in Mathematics. Students need to spent a great deal of time as well as effort in the learning of Mathematics so as to be motivated to want to continue wanting to learn the subject. They should not be treated as passengers but as active participants. According to Ajogbeje and Alonge (2012) teacher competency is also crucial. Teachers should demonstrate competency in the pedagogic content knowledge of all the chapters in the book. Also of importance is the constant and frequent feedback and remediation by the teachers. The provision of feedback and remediation on the learners necessarily improve performance in Mathematics. Remediation aids in correcting deficiencies in learners with the intention of making them be on the same level with other learners. Teachers who use interactive methods achieve active participation for their learners. Discovery methods, group work and project work have proved to be effective methods in teaching and learning of Mathematics.

2.1.3 Mathematics phobia in secondary school students

The Fear of Mathematics

Mathematics is considered as the one of the most prominent subjects in school level education due to its importance in day to day function of the people. It has long been recognized as an essential requirement for everyday life and for most occupations. Mathematics is often considered as a difficult subject by many students in schools education (Capuno *et al*., 2019). Feeling mathematics as difficult for students affects not only their liking of mathematics but also their perseverance, interest, boredom and self-efficacy beliefs related to mathematics

(Gafoor & Kurukkan, 2015). Fear of mathematics is not only the case of the particular places or the persons. It is a global issue. The fear about mathematics is causing the students negative attitude towards mathematics and hindrance the learner from focusing on the problem which they are tackling. The fear of mathematics also tends to the learner get nervous especially during the time of the test or examination, fear clouds their minds and the students could not perform as well. Some of the reasons attributed to the fear of mathematics may develop earlier to the learner and may have several possible causes like: hereditary, social and environmental. Fear of mathematics may create due to the influence of the parents, teachers, classmates and seniors. In the same way, negative perception towards mathematics also may cause the fear of mathematics.

Meaning and Types of Phobia

A type of anxiety disorder or a mental illness that makes someone very worried and affects their life is known as phobia. It involves an extreme fear of something or irrational fear of a specific situation, activity and object or that leads to compelling desire to avoid it (American Psychiatric Association, 2013). The term 'phobia' is abstracted from the Greek word "phobos" meaning fear, panic fear, or terror. In the simple terms, the meaning of phobia is "fear". Usually a person has phobias to a number of objects or situations. Phobias can be divided into three categories as: specific phobias, social phobia, and agoraphobia (Hamm, 2009). Specific phobias include the fear of certain animals, natural environment situations, blood or injury, and specific situations. Social phobia appears when the situation is fearful for the person who is worried for being judged by the other persons. In the same way, agoraphobia is a generalized fear of leaving home or a small familiar 'safe' area, and of possible panic attacks that might follow. Sometimes the phobias are produced by the negative experience with the object or situation.

Mathematics Phobia

There are different types of phobia (fear) such as: fear of water (hydrophobia), fear of height (alto phobia), and fear of performance and so on. One of them is mathematics phobia. It is a fear of mathematics. It can be defined as a feeling of anxiety that stops one from efficiently tackling mathematical problems. Mathematics phobia is regarded as mathematics weakness in students that deals with psychological dimension of learning (Olaniyan & Salman, 2015). Tillfors (2003) defined phobia as learned emotional responses and it causes frequent severe and intense anxiety. Many people have a negative perception about mathematics that it is an extremely hard subject which they cannot master. This negative perception weakens them from focusing on the subject and as a result they get comparatively less performance in the tests or exams. Consequently, fear increases day by day towards mathematics and eventually it develops in the form of phobia.

The lack of ability in mathematics innumeracy has received increasing attention in the last few decades. The ability to use basic mathematics is more important as the modern day's society has become more complex. Some children may have some problems with mathematics due to some reasons. According to Geary (2013), one cause of the problem in mathematics may be a fundamental deficit in the representation of numerosity. It occurs at different ages in different people for different reasons. The specific mathematics phobia which is basically comes due to the arithmetic or fear of numbers. Such phobia is called arithmophobia or numerophobia. The words arithmophobia and numerophobia both have Greek origins where the root word stands for 'numbers', and 'phobos' meaning 'deep dislike or fear'. This type of phobia affects student’s attitude towards mathematics and often creates ridiculous fear of numbers. There are several reasons behind the mathematics phobia viz. the ignorance for the subject, discontinuity in concept learning, lack of concentration and practice, avoiding participating in teacher learning process, open insult by teacher, parents, and peers, low scores in the subject and the negative perception about mathematics. This fear is somewhat unusual in that it encompasses a wide variety of specific phobias, including a generalized fear of all numbers and fear of specific numbers. It is classified as an anxiety disorder.

Types of Mathematics Phobia

The mathematics phobia is classified into two types as general and specific arithmophobia or numerophobia. General arithmophobia is the fear of all numbers that can seriously affect the ability of the students to do mathematics. This limits both educational and professional opportunities. Specific arithmophobia is the fear of some specific numbers that some people may be affected by this phobia. This type of phobia is usually rooted by superstition or religious phobias. The specific phobia is less serious than general arithmophobia. The best example of specific phobia is a fear of the 13 number, it is known as triskaidekaphobia. This fear has been linked to early Christians, and the number 13 appears in a lot of Biblical traditions. The number 13 is considered as the unlucky number in that religion. Even today, many hotels in the western society omit the 13th floor and room number with the fear of the number 13. In the same way, the number 666 is another number that's widely feared in western cultures. It is said to be the "number of the beast" as translated into English versions of the Book of Revelation verse 18. The number 4 is considered as an unlucky number in Asia countries like China, Vietnam, and Japan because it is something of a homophone for the word "death" in the local languages. Just like in the west, hotels are prone to omitting the number 4 out of their floors and room numbers, and corporations have even followed suit, the serial numbers of Canon cameras don't include the number 4, and Samsung phones no longer use model codes with 4 either.

Many people of all over the world fear with numbers. Some might fear from one number and other fears from another number considering their culture, religion, place of birth and region.

Country like Nepal, India, Bhutan and Myanmar, people who follows Hindu religion, they consider the numbers 0, 1, 8, 10, 12, 19 and 28 as unlucky numbers, bad luck or evil spirits etc. These numbers are called oudenophobia, henophobia, octophobia, decaphobia, dodecaphobia, enneadecaphobia and eikosioctophobia respectively. They always fear from these numbers. In contrary to the above, especially the people from Nepal and India assume the number 7 as the lucky number and they like to choose this number and they don't fear. In China, the number 8 and multiples of 8 are considered as the luckiest number and they believe that the number brings wealth and good luck. Similarly, Chinese young people in slang word use 520 as the symbol of conveying love (I love you) to their best friend. However, especially in Nepal and India, people used 420 to convey as the bad character. Thus, due to different religious and cultural superstition, people surrounding these places may have different understanding about the number. The understanding may be positive or negative depending on their religious and cultural superstations. Such irrational beliefs about number create fear to the each and every learner.

Causes of Mathematics Phobia

Mathematics phobia can be occurred due to different causes. As concluded by Ihechukwu & Ugwuegbulam (2016), lack of different aspects related to teaching learning like: good teacher-student relationship, use of students-centered/innovative approach of teaching, counseling, positive attitude towards mathematics, improved mathematics curriculum, breaking down topics into units, application of ICTs in teaching mathematics etc. can cause mathematics phobia. According to Foley *et al*. (2017), mathematics anxiety is learned not from personal experience but from parents and teachers. As reported by Foley and colleagues, a study done in India found out that, parents with high mathematics anxiety unintentionally convey the idea that mathematics is difficult and anxious while helping their children's homework. In the same way, the study done in America found out that the level of mathematics anxiety depends on their teacher. The children read the subtle body cues of their elders to determine whether mathematics is something to fear or to feel good about. The students who get nervous on any occasion in the case of mathematics are caused by mathematics phobia. Thus mathematics phobia is mainly caused by the test and examination(due to the pressure to perform well), people (individual, parents, teachers and peers) due to individual low proficiency, parents concept of difficulty, teacher poor knowledge delivery and peers negative feeling toward mathematics and nature of mathematics (due to abstract nature and not to relate all aspects in real life). The following points may be the causes of mathematics phobia:

i. Weak teaching method and weak mathematics background
ii. Teachers' aggressive, stressful and irritating characteristics
iii. Inability to solve mathematics problems
iv. Bad relationships between a teacher and a student
v. Inability to solve too much home assignment
vi. Not to understand mathematics in class
vii. Unable to solve mathematical tasks
viii. Use of abusive words by teacher
ix. Negative attitude towards mathematics
x. Not able to solve mathematics problem in time
xi. Not to be child-friendly teaching environment
xii. Mathematics learning difficulty (dyscalculia)
xiii. Community Influence (negative perception)
xiv. Low self esteem
xv. Lack of analogies

Symptoms of Mathematics Phobia

Mathematics phobia is a feeling of anxiety that appears due to the fears of solving different mathematical problems. Some people call mathematics phobia as a tension, panic, helplessness, and mental disorganization. The feeling of phobia in long term can have a negative impact on health of the person and also lose the desire to learn the subject further. Hence, any types of phobia should be eliminated at the very beginning stage not to evolve into more serious problems. In the same way, mathematics phobia has the following symptoms:

i. Try to avoid numbers
ii. Getting confused and disorganized
iii. Apparent choking sensation
iv. Anxiety, depression, and panic
v. Fear of doing anything else
vi. Sweating, trembling or getting hot flushes
vii. Problems with breathing
viii. Breathing rapidly and tightness in the chest
ix. Nausea, headache and fainting
x. Unable to express one's thoughts clearly
xi. Immediate desire to leave classroom
xii. Get detached from reality
xiii. Shows avoidance behaviour
xiv. Getting nervous and stressed when assigned to solve mathematical problems
xv. Skips classes and irrational thinking.

2.1.4 Academic achievement

Teaching and learning process cannot be completed without finding out the extent to which the set objectives are achieved. The essence is to determine progress students made in learning the concept, principles and theories presented to them in the course of teaching. The outcome of the exercise is academic achievement, which represents the extent to which a student, teacher or institution has achieved their educational goals. Academic achievement has become an index of a child's future in this highly competitive world. Academic achievement has been one of the most important goals of the educational process. It is also a major goal, which every individual is expected to perform in all cultures. Academic achievement could be seen as the level of performance in a particular field of study. Egbule (2014) saw academic achievement as high scores obtained by students in an examination. The high scores are indices, symbols or marks which characterize the students' achievement. It is an indication of amount or level of knowledge an individual learner possesses in a given subject area as opined by Egbule (2014). Crow and Crow (2011) defined academic achievement as the extent to which a learner is profiting from instruction in a given area of learning, that is achievement is reflected by the extent to which skill or knowledge has been imparted to him or her. However, academic achievement is a key mechanism through which students learn about their talents, abilities and competencies which are an important part of developing career aspirations (Lent, 2010). Academic achievement and career aspirations in adolescence are often correlates (Abu-Hial, 2012). The outcomes of achievement in mathematics by students in external examination have not been encouraging or impressive as recorded in the West African Examination Council (WAEC) result from 2008 to 2011.

Academic achievement, most especially of secondary school students, has been largely associated with many factors. In recent time, literature has shown that learning outcomes (academic achievement) has been determined by such variables as family size, society and motivational factors (Aremu & Oluwole, 2011), socio-economic status, students' employment status, student interest, teaching methods and school entry modalities (Cameson & Wilson, 2011). In the same vein, Parker *et al.* (2013) noted that much of the previous studies have focused on the impact of demographic and socio-psychological variables on academic achievement. The nature of curriculum that has made it practically difficult for students to transfer, generalize and construct an essential understanding of the subject (Aremu &

Oluwole, 2011), the nature of mathematics which spans from arithmetic and geometry to being science of abstract, teachers' preparedness, lack of competent and qualified teachers, lack of interest in mathematics among the students (Aremu & Oluwole, 2011) among others have also been identified in the literature as reasons for poor academic achievement of students in mathematics.

More recently another emerging dimension to the determinants of academic achievement is students' personal and teacher factor (Aremu & Oluwole, 2011). The students' variables are study habit, gender, cognitive style, cognitive ability, emotional intelligence, cognitive level, age and attitude; while the teacher factors include: knowledge of subject matter, experience, classroom management skill, leadership style, teaching approach adopted. However, this present study focused on students' cognitive ability, gender and teaching method as determinants of academic achievement and retention in senior secondary school mathematics.

2.1.4.1 Student achievement in mathematics

Numerous problems emanate from the side of the Mathematics students that water down the quality of performance in Mathematics. Most of these are attitudinal. The attitude of the students constitutes problem to their grapping Mathematical knowledge. The assumption that Mathematics is just a read-and-understand subject like liberal Arts is a major problem of a mathematics student. Commonly, students shun practices of Mathematics not knowing that a true understanding of Mathematical system depends largely on the amount of time devoted to practicing it, unfortunately, they have not been able to apply them to appropriate situations.

They are found of memorizing solutions and formulae without any attempts to understand or query their derivation or relevance. Little wonder, they are often in a fix when they are required to solve problem which are new to them, as this method of learning by role gives little or no room for mental development and creativity. Despite the importance and the contribution of Mathematics to nation building, mathematics is still been dreaded by secondary school students (Oyeniran, 2011). Some students consider Mathematicians to be special people. They believe Mathematics is highly structured and abstract that its study required some intellectual talent. "How would any person in fairness expect our poor and innocent children to be as courageous as to face something which is capable of making even an adult to be mad?" Obodo (2015) observed that Mathematics is not as bad or difficult as it is painted by some students, but that students sometimes prefer doing other difficult things than attending Mathematics class because of their hatred for the subject which invariably leads to student's low achievement in the subject. Ibok (2012) observed that students' performance in Mathematics is low because Mathematics students are not acquiring the skills and understanding they needed to participate effectively in the culture, political and scientific environment later in future.

2.1.4.2 Sources of student under achievement

Several scholars have identified the source of students under achievement in Mathematics in Nigeria but Hannah (2015) stated it as follows:

i. Poor method of instruction

ii. Lack of problem solving abilities

iii. Students negative attitude toward the students

iv. Limited background preparation in Mathematics and

v. Mathematics fright

The programme of instruction should inculcate in the learners the spirit of critical investigations, conjecturing, hypothesizing and experimentation for them to be able to prove their skills as they come actively engaged in doing Mathematics through problem posing, problem analysis, problem solving and accelerated classroom discourse. There is a need for the adoption of some learners centered activity. This could enhance learners understanding and this improves their academic performance. A poor interest towards Mathematics is thought to plague learners at every level of schooling. The fear of answering Mathematics questions, in classroom and/or taking Mathematics test often escalate to a level termed Mathematics anxiety which contributes to the poor performance in Mathematics. Adebule *et al.* (2016) attributed three principal factors as inhibiting to Mathematics achievement among secondary school students. These are:

i. Home background problem which occurs during the early childhood period,
ii. Environmental background limitations which occur as the child develop through childhood to adolescent; and
iii. Edifying background preparation in Mathematics in the primary school, a condition he termed to be a carryover effect. Adebule *et al.,* (2016) was categorical about attitude and commented that there was no special gift or qualities of mind to learn Mathematics. It is stressed that the subject is within the grass of anyone. This attitude of pupils who are incapable of performing well in Mathematics can hence be related to their wellness to choose, to grasp or not to grasp the subject. Laziness, nonchalant attitudes, indifference, abandonment, unwillingness, disinterest or downright surrender are elements which can be deduced from Kline's principle on studying Mathematics as a subject. Therefore, the students' attitude towards the teacher many be important in the formation of Mathematics attitude.

2.1.4.3 Effectiveness of teaching strategy and students performance in mathematics

It is possible that the inability of the students to relate what they learnt in the classroom to real life situation or solve Mathematics problems have a significant relationship with higher order of thinking (Oyeniran, 2011). Students are not positively disposed to the study of Mathematics and perhaps they do not have sufficient opportunity for problem solving activities. Students do not consistently demonstrate certain desired level of critical thinking which can facilitate their understanding of Mathematics and asserts that problem solving strategy developed by the researcher which was used to teach Mathematics concept consists of nine major procedural steps which include:

i. Presentation of problem by teacher

ii. Identifying the variables in the problem

iii. Student to define the problem in his language

iv. Making plan to solve the problem

v. Carrying out the plan

vi. Exploring alternative approach

vii. Observe and tabulate the result in step iv and vi

viii. Check the result by looking back to step i-vii

ix. Generalize and apply approach to similar problem as in step i-vii

Harbor-Peter (2011) believe that for teachers to meaningfully enhance learning and enhance interest in Mathematics, they should tap heavily from devices which have direct sensory appeal and at the same time exhibit and clarify Mathematical concepts and relations, such that include heuristic problem solving strategy. The proper use of such strategy has complete psychological justification. This kind of instructional technique is likely to facilitate student's Mathematical problem solving abilities so as to improve student's performance in the subject.

2.1.5 Attitude of student in learning mathematics

Attitude refer to the affective aspects of mathematics learning such as: beliefs about mathematics and its usefulness, interest and enjoyment in learning mathematics, appreciation of the beauty and power of mathematics, confidence in using mathematics, perseverance in solving a problem. Badmus (2012) argues that the measurement of attitude is a complex matter and cannot be observed directly but can be inferred from the way individual student reacts to a particular stimulus or situation. In education, attitude is one of the important elements which determine students' success.

According to Effandi and Normah (2009) students' attitudes towards mathematics are very much related to their attitude towards problem solving in general. They add that negative attitudes need to be overcome, so that later in life, students will not suffer from poor problem-solving skills. It is important to master problem solving skills as these skills are essential for dealing competently with our everyday life. Their claim is supported by Badmus (2012) who points out that students must have positive attitude towards problem solving if they are to succeed. He proposes that solving problems requires patience, persistence, perseverance and willingness to accept risks. This concurs with Harbor-Peters (2015) claims that students with positive attitude towards mathematics will generally excel at it. Prompt the need to carefully look into aspect and influence instructional material in the enhancement of student academic success especially in Mathematics.

2.1.6 Methods of teaching mathematics in secondary schools

There are several methods of teaching which teacher of science subjects can use in the classroom to presents scientific facts, information, principles, skills or concepts to students. Some of the methods include: demonstration, discovery, discussion, project, laboratory, individualized, field trip and expository methods to mention but few.

Some of these methods which have their characteristic advantages and disadvantages as narrated by Hopkins (2012), are specific for some situations and categories of students, while others can generally be apply to all categories of students. For the purpose this study, the relevant teaching method amongst the above listed are discovery and expository methods and would be discussed below.

2.1.6.1 Guided discovery methods

The value of discovery has been the subject of debate and some disagreements among educational psychologists. As explained by Mayer (2015) claimed to have established that guided discovery was the best method (of those used) to promote the learning of certain rules. Mayer (2015) argued that guided discovery only looked better because of what it had been compared with, usually-rote learning. He went further to claim that there was just no evidence that discovery of any kind was a more effective teaching method than meaningful exposition. Clute (2011), agree that discovery is important in promoting learning with young children, while on the order hand agreed that active learning methods are more important for younger students than for elder ones. Yet guided discovering is quite popular with some teachers. They believed the students are better motivated by an active approach and perhaps by a challenge, but the teacher may justifiably step in at any time to ensure that the desired end point is reached.

Perhaps the most eloquent defender of learning by discovery is Mayer (2015), who claimed that; first, discovery encouraged a way of learning mathematics by doing mathematics and encouraged development with view that mathematics is a process rather than a finished product. Secondly, in agreement with Yapwi (2015) discovery was seen as intrinsically rewarding for students, so that the teachers using discovery methods should have little needs to use extrinsic form of reward. Thirdly, discovery learning, teaches students the techniques of discovery. Solving problems through discovery develops a style of problem solving or inquiry that serves any task that one may encounter. Finally, discovery learning results in better retention of what is learned because the student has organized his new information and know where (in his own storage system) to find the information when he needs it. Now, these points carry great weight, Practical difficulties were acknowledged namely; that one could wait forever for students to discover, that the curriculum could not be completely open. Some students might even fine their inability to discover extremely discouraging. It is of course up to the teacher to make the kind of adjustment necessary to circumvent these difficulties. Such practical difficulties did not invalidate the case for active learning.

Therefore, the effort of trying to use discovery methods will be worthwhile for what is to be achieved.

More recently, in the wake of the Idigo (2010) opined that there have been developments aimed at ensuring that secondary school mathematics curriculum does involve an element of more active learning, which is discovery method. The efficiency or otherwise of discovery method is however under debate. Mayer (2015) has commented upon the issue that “One cannot compare, say ‘discovery teaching’ with ‘non-discovery teaching’ One can only compare some specific attempts to do discovery teaching, some specific attempt to do ‘non-discovery’ teaching”. Supporters of discovery learning may therefore, to a large extent be accepting a belief, summed up by Hopkins (2012) that, “I believe this discovery is the best way of exciting our students in mathematics”. He also believes that it is only when students are given chance to think him/her-self, that they realize their full potentials.

Without controversy, Udoh (2014), pointed out that student who should be given chance to think for himself must have been exposed to ideas that form his prerequisite knowledge. Without such exposure, he may have no basic knowledge from which his thinking will spring forth. This is to say that expository approach supplement discovery approach. Hence to draw a sharp line of contrast between the two approaches may be more and academic exercise than nature. A study which requiring a comparison of the two approaches requires a substantial amount of case study by the researcher. With this in mind, this important method of teaching mathematics will be used to teach students with mathematics, while its efficacy or otherwise improving their mathematics achievement will be shown. Another important method used in the study is the expository method, the potentials of which are hereby discussed latter.

2.1.6.2 Learning mathematics by graphical approach

Classification of teaching method, we may define expository teaching as the situation in which the teacher considered that photographs, pictures and illustrations differ from the commercially available graphic symbol sets to enhance learning (Umoren, 2012). In contrast to her role in inductive discovery learning, the teacher presents the student with the entire content of what is to be learned in final form. According to Udokang (2012) the students are not required to make any independent discoveries. The usual verbal instruction of the lecture hall exemplifies the expository teaching. It is sometime called Deductive teaching because the teacher often begins with a definition of the concepts or principles, illustrate them, and unfolds their implications. Although expository teaching is a widespread and tradition teaching practice in our schools and colleges, it has attracted very little research said (Ebong & Agabi, 2015).

The students presumably can only memorize the lecture by constant review and repetition. Indeed it is possible to present a body of materials so poorly that unless the students commit to rote memory, they have little or no way of remembering it. However, expository teaching can present a rich body of highly related facts, concepts and principles which the students can learn and transfer. To these advantages Udo (2010) adds that expository teaching is more popular in our schools today because it is more efficient and takes less time than discovery learning. When combined with practice, it is very successful in teaching concepts and principles.

Graphical teaching offers students the opportunity to obtain and organize views of the discipline he is studying because the teacher can organize the field more efficiently for learning than the novice student can. Gallenstein (2014) said that in discovery learning, the concern to teach the techniques of discovery overrides the concern for learning the unifying principle of a discipline. Udo (2010) and other adherents of discovery methods contend that discovery method is the best method for transmitting subject matter, problem solving is the Secondary goal of education, there can be training in the techniques of the discovery; expository teaching is authoritarian; and the discovery methods are unique generators of motivation and self-confidence. However, Irvin (2011) countered that the Secondary purpose of teaching is to present in some systematic way an organized body of knowledge. The organization should be explicit form to the students. He does not believe that you teach creative thinking and critical thinking outside the context of a specific discipline. Adopting a precise, logical, analytical and critical approach, which fosters appreciation of the scientific method in that discipline, he contends, can only teach such thinking.

Both discovery and expository methods are good methods of teaching mathematics as shown above. But, looking at the relationship of these two methods with mathematics aversion and how they affect mathematics achievement will sharpen our focus on the study.

2.1.6.3 Graphical representation in mathematics learning

Mega mathematics (2014), said that when mathematics talk about graphs they are mostly likely to be thinking of collection of dots and lines that you see in the illustration of this section. Sometimes, graphs are called networks, and a glance at pictures of them will show you why. Mega mathematics further added that graph could be seen as one of the mathematical objects, which make mathematics learning more transparent. Graphical-symbol will make ratio learning transparent.

Graph game show that a number is also a mathematical object that is probably the most familiar to everyone. Some other mathematical objects are knots maps and infinite state machine, linear graph and picture representation will make ratio learning more transparent. The idea of graphical-symbol approach will help pupils to make ratio relationship more transparent.

National Council of Teachers of Mathematics of American (NCTM) Cooney (2012) gave a recommendation which includes in their goals that pupils in grades 3 – 6 should be able to represent data using tables and graphs such as lines and pots bars graphs and line graphs, pie chat stem graphs (standard), graphical-symbol approach will serve positively in ratio learning and the idea of linear graph should be introduced to make a very important point about this goal of (NTCM).

Effiong (2012), suggested that teachers should not “get overly anxious about the tedious details of graph construction”. According to Effiong, teachers should take one or two approaches to graph construction. Pupils should either be encouraged to do their best when creating their own graphs or that student should use technology and computer to generate exact graphs. Some types of graphs that should be taught include bar, stem and leaf plots and continuous data graphs. Effiong has been encouraging the use of graph in Secondary school mathematics learning. As he had been mentioned the other types of graphs used in Secondary school.

2.1.6.4 Approach to mathematics teaching and learning

Eniayeju (2015) said that after some years at least 10 years of experience, teacher will find it difficult in helping their students to discover mathematical ideas for themselves without involving them in activity-method.

The approaches in mathematics teaching and learning enable the pupils acquire mathematics skills. Some of the approaches are:

Area Title Approach: It is the type of approach whereby Tiles are used in teaching of area to the pupils. The tiles represent the square units. Eniayeju (2015), ‘Encourage the Area Tile Models’ Approach in teaching of area in Secondary school. It will bring area learning home and realistic to children because tiles are what they can see in homes and schools. It makes a mathematics learning begins from known to unknown-from real to abstract. Which graphical-symbol method will also do in ratio learning?

Discovery Approach: It is the type of approach whereby a pupil is guided to build mathematics ideas, to think more to discover things by themselves. Alesandrini (2012) said that discovery approach as a pupils-dominated and activity-oriented method of teaching and learning of mathematics. With graphical-symbol approach, discovery will be more encouraged because the pupils will be allowed the view the graphical-representation and discover the given ratio relationship vividly.

Laboratory Approach: This is the type of approach whereby the pupils are led to find the importance of the mathematics tools and instructional material, which they have in learning mathematics. Usman (2012) emphasized that the pupils are made to carry out some measurements often using simple equipment such as rulers and compass, collect data by experimentation or discovery, making drawing and models, make computational devices, and perform experiments with materials. The graphical-symbol approach will also encourage this approach more because some of the materials such as graph sheets, ruler, and pencils are to be used in plotting of the graphic in ratio relationship.

Target-task Approach: In this approach the pupils will first of all give some hander topic to solve which they may or may not be able to solve. After that an easier problem will be solved with help of the teacher’s guidance.

With graphical-symbol approach, some difficult ratio problems which have been given to the pupils to solve can now be solved graphically and easier with a simpler understanding.

Small-group Approach: This approach is the type of approach whereby a mathematics teacher group pupils in smaller groups during mathematics learning. For graphical symbol approach, small group approach will be more effective because the teacher will group the pupils and give them some ratio problems to plot graphically.

2.1.7 Models and modeling in secondary school mathematics learning

Harbor-Peters (2011), conceptualized models for mathematics teaching and learning as enriched devices which may be concrete or semi-concrete or abstract for use by teachers to make mathematics concepts clearer to learners. Harbor further stated that a model must possess a one-to-one correspondence relationship to the mathematical concept being illustrated, using the model. It must be simple and easy to use so that one does not use the teaching time for explaining the models. With that, graphical illustration would also serve as model in mathematical learning. In general, good models for teaching mathematical concepts are capable of providing concrete and realistic experiences, which will help a learner to discover facts or patterns. It creates curiosity and motivates the learners to explore mathematics in a relaxed mood.

With regard to Harbor Peters view on models as instructional materials in mathematics learning, Secondary school pupils would be motivated to develop interest in ratio learning when it is properly taught with graph sheet as a model.

Suydam and Hggins (2012), viewed models as, “two or three-dimensional representatives of objects which students learn about in the class”. The use of models provides a mental of relating past experiences to a new situation. They employed and provide concrete and realistic experiences from which learners can discover facts. The minds of the students will readily accept ideas that are illustrated by concrete example. The means that model give meaning to different concepts and relations in mathematic by associating them directly with physical objects. It was further explained that concept of the model is restricted to mean only those concrete devices used by mathematics teachers and students to demonstrate mathematical concepts. Models therefore, should represent the natural objects, they are meant to represent. Which graphical approach can do in ratio learning?

According to Umoren (2012) mathematics models can be considered as a simplification or abstraction of a (complex) real world problem or situation into mathematical problem. It was further explained that mathematics problem can be solved using whatever known techniques to obtain a mathematical solution. This solution is then interpreted and translated into real term.

Gagne (2014) viewed a model as a visual or picture, which highlight the main idea of a variable in a process or system. Gagne further stated that the use of model as learning aids have two Secondary benefits. Firstly, models provide accurate and useful representations of knowledge that is needed when solving problems in some particular domain. Secondly, a model makes their process of understanding a domain of knowledge easier because it is visual expression of topic. It was found out that pupils who study with models may recall as much as 57% or more on questions concerning conceptual information than pupils who receive instruction without advantage of seeing and discussing models.

With the view of Gagne, graphical-symbol communication will be a useful model in ratio learning, which will help Secondary school pupils to understand ratio-relationship visually, Alesandrini (2012) came with his own idea similar in conclusion, when he studied different pictorial-verbal strategies in learning from his research on the effectiveness of pictorial-verbal representation. From his own study, the learner draw their own conclusion that the act of building the model and running the simulation gives them a deeper understanding of the sensitivity of the cycle outside disturbances and reinforces the concepts underlying the model.

Richard (2016), view model as being a representation. Richard further said that motivation might be found by providing tools for designing interactive stimulation. Simple interaction with model provides a far more interesting exercise than observation. With his definition, Graphical-symbol model will serve as a tool in ratio learning and bring interaction stimulation on the pupils and create more interesting exercise than through observation and passivity.

Norman (2015) said that one can have internal model. He viewed models as representation of reality that people use in the environment, with others, and with the artifacts of technology, people form internal mental models of themselves, and explanatory power for understanding the interaction. In ratio learning, mental model will be transformed into graphical-symbol representation, which will interpret the mental ratio model into visual ratio representation and interpretation.

Johnson-Laird (2015), viewed mental model as ("a basic structure of cognition"). It is now plausible to suppose that mental model play a central role in representing objects, states of affairs, sequences of events, the way the world is, and the social and psychological action of daily life according to Holland (2012) who suggested that mental models are basis for all reasoning processes. With these views, graphical-symbol approach in ratio learning will create a visual framework, which will bring visual illustration to relate mental model to visual model.

Ryder (2014) view model as myths and metaphor that helps us to make sense of our world. Whether it is derived from which or from serious research, model is a means of comprehending an otherwise in comprehensible problem. According to Ryder an instructional design model gives structure and meaning to an identity problem enabling the designer to negotiate her design with a resemblance of conscious understanding. Model helps us to visualize the problem, to break it down into discrete management units. Hence in ratio relationship, graphical-symbol model will reduce cognitive stress and increase visual idea, which will make ratio learning more realistic and for easy understanding. Ryder further stated that pupils who are engaged in the model building process must pull together science content, mathematics skills and logical problem solving. Skill manipulating materials, are also regarded (as concrete models) in mathematics learning.

Lesh (2014), suggested that concrete models can be effectively used as an intermediation between the real world and the mathematical world. He contended that such used world tend to promote problem-solving ability by providing a vehicle through which children can model real-world situations. The use of concrete model in this manner is thought to be more abstract than the actual situation yet less abstract than formal symbol. With Lesh's idea, graphical-symbol approach will model ratio relationship visually and graphically and make it to depart from traditional ratio learning.

Borne (2010) viewed concrete models as those objects that can be touched and moved by pupils to introduce and reinforce a mathematical concept. Hartshrn (2011) suggested that manipulative materials are particularly useful in helping pupils move from concrete to abstract level. Teachers, however, must choose activities and concrete models carefully to support the introduction of abstract symbols.

Borne (2010) divided the transition iconic level (the level between concrete and abstract) abstract levels in the following way:-

The semi concerted level is a representation of a real situation; pictures of the real items are used rather than the items themselves. The semi abstract level involves a symbolic representation of concrete item but the pictures do not look like the objects for which they stand. Howden (2015) placed specific concrete models as those manipulative ranks from the concrete to the abstract. In place value, for example (going from concrete to abstract), they include pebbles, bundled straws, based ten blocks, chip trading and the abacus. Howden cautions that building the bridge between the concrete and abstract level requires careful attention. Graphical-symbol approach will transform ratio learning from visual to abstract level.

Suydam and Higgins (2012) said, "Mathematics achievement increased when manipulative materials were used". Graphical-symbol approach will increase achievement in ratio. Penner and Rich (2011) said that, when students have space and geometry, measure, and data at their disposal, as well as the more traditional forms of numbers sense, the transition to mathematical modeling of natural phenomena becomes feasible and powerful, even in the physical models of elbows can lead in turn, to graphical and functional descriptions of the relationships between the position of a load and the point of attachment of the tendon. Thus elbows can be modeled as third class levers, an idea we explored with third grade pupils.

Umoren (2012) said that “mathematical modeling has recently become a prominent term among mathematicians and the users of mathematics, particularly in science and technology”. Graphical-symbol will help the young users of mathematics to process ratio relationship graphically. Allen (2013), view mathematics modeling as the total process involved in the steps we go through when we use mathematic to deal with any real situation that we have Graphical-symbol communication will be used to process ratio relationships visually.

Lassa (2014) view mathematic modeling as a unifying theme for all application of mathematics, but key steps in any activity in technology and indeed in most forms of the modeling process. Lassa further said that mathematic modeling is one particularly powerful way of representing reality. It is usually better in technology to have some mathematical model to be accurate. He said that the teaching of mathematics modeling is one new approach to the teaching of mathematics because of the need to make mathematics more relevant to everybody life. Graphical-symbols approach will serve as a new approach in ratio learning in Secondary school level.

Umoren (2012) viewed mathematical modeling as a process of representing real world problems in mathematical term in an attempt to find solutions to the problems. Graphical-symbol communication will serve as modeling in ratio learning; it will be a process of real world problem in ratio relation and help the solution to graphical problem.

Mathematics Modeling Our World is founded on the principles that mathematics is a necessary tool for understanding the physical and social worlds in which we live. Mathematics Modeling Our World is a grade 9 – 12 curriculum, which included the Secondary six mathematics curriculum, in which pupils not only learn mathematics, they also learn to use mathematics, in solving their problems. MMOW support that pupils are taught to use a variety of resources to solve problems, and they learn to choose resources that meet the need of a particular solution.

With the view of Mathematic Modeling Our World, graphical-symbol communication will serve a variety resource to solve ratio problem that will meet the need of ratio solution. English and Halford (2012) said that, modeling involves the establishment of links among representations of a mathematical concept and its relationship to other concepts. More importantly a model needs to externalize the links to the learner in ways that would help him or her to visualize them. Graphical symbol model will externalize the ratio relationship to the ways that would help them to visualize the relationship. Furthermore, English and Halford explained that modeling involves the deputation of the relations that are embedded in a scheme both graphical or concretely. The modeling process could also contribute to expansion of Networks of schemes that are associated with mathematical concepts resulting in deeper understanding. Modeling activities must also have an inbuilt flexibility to help children externalize constituents of a model. These activities need to be grounded within the experiences of children, including observation of concerts in real life contexts. Explanation would also reveal conjecture about other situations and solved problems.

2.2 Theoretical Framework

Deep structural changes are needed in the ways that societies manage their economic, social and environmental affairs. Hard choices are needed to move from talk to action to bring about changes among the developing nations. Udo (2010) viewed discovery learning as method of inquiry-based instruction; that, it is better for the learners to discover facts and relationships for themselves. The theory is utilized in the creation of instructional environments. As it is with other field of leaning, discovery relies on the general theory of learning for the development of its instructional environment. Since technology has recognized how we live, how we communicate, and how we teach, Fox (2015).

Theoretically, this research work on the effect of guided discovery method on mathematics achievement on low and high averted secondary school students in FCT is based on the theory of guided discovery in learning. This theory is attributed to Bruner (2009) he viewed knowledge to be internalized by the learner through the process of accommodation and assimilation. That a child comes from a home and mingled with peer group that may not be interested in mathematics. When opportunity is given to them to construct things on their own, it may withdraw their averted mind. Fox (2015) believed that students construct their own reality or at least interpret it base on their perceptions and experience, so an individual’s knowledge is a function of one’s prior experiences, mental structures and beliefs that are used to interpret objective and events.

2.2.1 Constructivism and learning

Fox (2015), state that knowledge is constructed from experience and learning is a personal interpretation of the world. It is an active process in that meaning is developed on the bases of experience and conceptual growth comes from negotiation of meaning, the sharing of multiple perspectives and the changing of our internal representations comes through collaborative learning. Learning should be situated in realistic setting, testing should be integrated with the task and not in a separate activity. Learner constructs their own knowledge. Students are encouraged to be creative in searching for the actual result. Nwosu (2015) stated that with the constructivist model of instruction, students redefine, recognize, elaborate and change their initial concepts through interaction within themselves and their environment.

2.2.2 Ausbel theory of meaningful learning

Ausbel theory of meaningful learning was propounded by David Ausbel in 1968. According to the theory, meaningful learning refers to the concept that learned knowledge is fully understood by an individual and that the individual knows how the specific facts relate to other stored fact in the brain. Ausbel's theory consists of three phases. They are; presentation of advance organizer; presentation of learning task or material; and strengthening the cognitive organization. Meaningful learning requires knowledge to be constructed by the learner not transmitted from the teacher to the student. It occurs when learners actively interpret their experiences using internal, cognitive operations and have prior knowledge to which they can relate new ideas.

Students are apt to engage in meaningful learning when they are encouraged to do so and guided in determining what things are most important to learn. To experience meaningful learning, students need to do much more than access or seek information. They need to examine, perceive, interpret and experience information. When meaningful learning occurs the facts are stored in a relational manner. The brain stores them together because they are related to each other and when one fact is recalled, the other facts are also recalled that moment or shortly after. This is called spread of activation. This makes problem solving for students easier. The three phases suggested in the theory to ensure meaningful learning were being employed in this study. The first phase was presentation of advance organizer. This is synonymous to the first, second, and third steps of AIM, which is preparation of students for participation, climate setting, and mutual diagnosing of needs respectively. Also, the second phase suggested in the theory was presentation of learning task or material. This is related to fourth and fifth steps of AIM, which are mutual formulation of objectives, and mutual planning of learning activities respectively. Lastly, the third phase is strengthening the cognitive organization. This is related to the learning activities undergone by the students taught with AIM, some of such activities are inquiry project, independent study, group study, and so on.

2.3 Review of Related Empirical Studies

Udo (2011) investigated the relative effectiveness of problem-solving, guided discovery, and expository methods of instruction on students' performance in redox reaction, considering their mathematics ability. It was a quasi-experimental research using non randomized-pre-test–post-test control group design with expository method as control. Two research questions and two hypotheses were formulated for answering and testing, respectively. A sample of 120 SS2 chemistry students drawn from 3-co-educational public secondary schools in Uyo Local Government Area of Akwa Ibom State was used for the study. Criterion sampling technique was used in selecting the sample. Two researcher- developed tests – Chemistry Achievement Test (CAT) and Mathematical Ability Test (MAT), with reliability indices of 0.76 and 0.68, respectively, determined using test-retest method were used in collecting relevant data. After investigations, the results showed that those taught using problem-solving method performed significantly better than those taught with guided-discovery and expository methods; expository approach was the least facilitative. Students' performance was observed not to be dependent on their mathematics ability. Consequently, it has been recommended that Chemistry teachers should always adopt problem-solving teaching approach in teaching redox reaction and other quantitative concepts in chemistry in view of its high facilitative effect on the students' performance.

Lowrie (2011) did a study in presentation and mathematics learning. Quasi experimental was used for the study. The research was carried out to identify the effect of representation of mathematics concept by using models. The study identified three categories of problem solving approaches to include visualizes, verbalizes, and both user and we as the role of imagery in problem solving. The study found out that 42% of the participants solving the mathematical participants solved the mathematical problems using the visual technique.

Okorie (2012) carried out a study on extent of use of visual aids in the teaching of mathematics in Okigwe and Owerri Educational Zone in Imo State. The research was a descriptive survey research. The research was carried out in all the secondary schools in the two above-mentioned educational zones. 55 mathematics teachers were chosen in the schools and were used. 850 students were randomly selected from the secondary schools. The main instrument used for the data collection was questionnaire, seven research questions were tested, and five hypotheses were made. Two sets of questionnaire were administered to the two groups of respondents by the researchers themselves. Pearson's moment correlation technique was used to compare the response. A correlation co-efficient of 0.81 was obtained from pilot study. This was considered high enough. Chi-square was employed in data analysis.

From the findings, it was concluded that visional aids are of immense important in teaching and learning of mathematics. They spaced the lessons and spread interest hence reducing boredom that is often necessitated due to the abstract nature of mathematics. Instructional material helps to reduce verbalism and give a concrete touch to the teaching of mathematics. It is often said that seeing believes. With instructional materials students are convincingly taught mathematical facts without necessarily imposing facts on them and hence forcing them to cram these facts. Learning thus becomes natural and active participation of every member of the class is ensured. A combined effect of hearing seeing and doing will be enabling and ensuring retention. This study is similar to the present study considering the subject matter which is achievement in Mathematics, like wise in terms methodology which is experimental research design but differ in instructional approaches and as well as study population.

Emmanuel (2013) in worked on the "Impact of the audio-visual aids in the teaching of mathematics". The research was deceptive survey. It was carried out in the secondary schools in Otukpo in Benue state. 6 schools were used out of 10 schools in the area. Interview was used to collect data from mathematics teachers and students from the six schools. One hypothesis were tested, which stated, schools which employ more audio-visual aids in mathematics get better results in mathematics than those which employ fewer". Tables of percentages were used respectively for the presentation and analysis of the data obtained during the study. From findings, it implies that mean calculated was approximately 0.9. This implies that there is a strong positive linear relationship between dependent variable (x) and the independent variable (y) tested. This means that x increases, and also y increases. This means that when more audio visual aids are employed, in teaching and learning of mathematics, more students will pass therefore the hypothesis which employs more instructional materials in mathematics teaching, gets better results holds. This study is similar to the present study considering the subject matter which is achievement in Mathematics, like wise in terms methodology which is experimental research design. But differ in instructional approaches and as well as study population.

Ayla (2015) carried out a study on mathematics modeling approaching to the task in teaching algebra among students. The research was carried out with quasi-experimental design to investigate the effectiveness of using geometric models in teaching algebraic expansions and factorization to junior secondary. A total number of sixty – (60) students were selected randomly and grouped into mathematics modeling approach (MMA) group and traditional method (TM) group for the study. TM was used as control over MMA, which the researcher set out to test. Each group containing 30 students with equal males and females. The study was carried out in a mix school. The instrument used for the data collection was t-test. The test was organized in form of pre-test and post-test. The data were analyzed by use of (ANCOVA). Four research questions were tested and analyzed. Their scores were organized under MMA and TM and analyzed. The analysis of the pre-test revealed that there was equivalence in the mathematical abilities of the experimental and control groups at the beginning of the experimental. It was also found that there were significant differences between their performances. The mean performance of students taught using MMA and that of those taught using TM, the mean performance of boys taught using MMA and girls taught using MMA and the mean performers of girls taught using MMA and that of those taught using TM.

From the analysis the mean score of the students in the experimental group was 23.43 while that of those in the control group was 15.93. And since the mean score of those in experimental group was 15 – 93 and the mean score of those in experimental group was higher, the claim was that the Mathematics Modeling Approach (MMA) was better methods of teaching algebraic expansion and factorization than traditional or control method (TM or CM). This study is similar to the present study considering the subject matter which is achievement in Mathematics, like wise in terms methodology which is experimental research design. But differ in instructional approaches and as well as study population.

Thomas and Lasisi (2015) investigated effects of guided discovery and problem solving instructional strategies on achievement of secondary school students in Volumetric Analysis in Minna Metropolis, Niger State. A 3x 1 Factorial design was adopted for the study. The population consisted of senior secondary school two (SSSII) students with sample size of 238 students selected from six secondary schools in Minna Metropolis. The research instrument employed was a 24-item Chemistry Achievement Test (CAT) developed from Volumetric Analysis and was validated by six experts in the subject area. The CAT was pilot tested on intact class of Chemistry students and reliability of 0.88 was obtained using Kuder Richardson (K-R21). Students were pretested before the treatment began, and the reshuffled or disguised version of the CAT was administered after the treatment in the posttest. The data obtained from both pretest and posttest were analyzed statistically using descriptive statistics (mean, standard deviation) and inferential statistics (Analysis of covariance, ANCOVA) using Statistical Package for Social Sciences (SPSS) version 20.0.

The results showed that students in the experimental groups (guided discovery and problem solving) generally have higher mean achievement scores in Chemistry than their counterparts taught Chemistry with conventional teaching method (control group), and this indicates that guided discovery and problem solving strategies have enhanced achievements in Chemistry more than traditional method of teaching. ANCOVA test also revealed that there was a significant difference among the students taught Chemistry using the three instructional strategies, and Scheffe post hoc test indicated that students in the guided discovery group achieved better The hierarchical order of achievement of Chemistry students vis-à-vis the instructional strategies considered in this work is established as: Guided Discovery Problem Solving Conventional Teaching Method.

It is concluded that guided discovery and problem solving strategies are more effective in enhancing students' achievements in Chemistry than the convention teaching method. Thus, it is recommended that teachers should expose Chemistry students to guided discovery and problem solving instructional strategies that promote and encourage social interaction, active learning and ultimately enhance achievement. The stakeholders in education sectors should also encourage and enforce the use of guided discovery and problem solving instructional strategies in teaching and learning of Chemistry in particular and sciences in general in our secondary school. This study is similar to the present study considering the subject matter which is achievement in Mathematics, like wise in terms methodology which is experimental research design as well as instructional approaches. But differ in study population.

Hidayati *et al.* (2018) conducted a study on the comparative of mathematics learning using guided discovery method and expository method to mathematics learning outcomes. This study aims to determine the difference in mathematics learning achievement between students in the learning using guided discovery method with students in the learning using expository method in students of class XI in Madrasah Mu'allimaat Muhammadiyah Yogyakarta Year 2017/2018. Quasi experimental method with a posttest only control group design research design was used for this study. In this study there were two classes compared to giving different treatments. The population in this research is all students of class XI in Madrasah Mu'allimaat Muhammadiyah Yogyakarta academic year 2017/2018. The sample in this research will be taken by cluster random sampling technique and obtained class XI D and XI E as sample. Technique Data analysis using Test prerequisite analysis which includes Test normality and Test homogeneity then done by t-test. The result of the research shows that there are differences of students' mathematics learning outcomes between students using guided discovery method with students using expository method in students of class XI Madrasah Mu`allimaat Muhammadiyah Yogyakarta academic year 2017/2018. This is shown by t-test of two parties obtained the result t_count = 39,7926> t_table = 1.9949 at a significant level of 0.05 and degrees of freedom (dk) = 69. Next do a one-party t test with t_count = 39 , 7926> t table = 1,6672 at significant level of 0.05 and degrees of freedom (dk) = 69 which means Guided discovery method is more effective than expository method toward mathematics learning achievement of grade XI Madrasah Mu`allimaat Muhammadiyah Yogyakarta Academic Year 2017/2018.

Slamet *et al.* (2020) investigate the effect of contextual group guided discovery (CGGD) learning approach on students' mathematical understanding and reasoning. This study was conducted through a quasi-experimental method with a control group pre and post-test design. The participants of this study were two groups of 4thgrade students in Kuningan, Indonesia. Each group was comprised of 22 students (N=44). While the experimental group was conducting mathematics learning with the CGGD learning approach, the control group was conducting mathematics learning with problem based learning (PBL). The data were collected through a test of students' mathematical understanding (TSMU) and a test of students' mathematical reasoning (TSMR) developed by researchers. The results showed that there were significant differences in the gain score of students' mathematical understanding (SMU) ($U = 134.00$, $Z = -2.539$, $P = 0.011 < 0.05$) and students' mathematical reasoning (SMR) ($U = 139.500$, $Z = -2.412$, $P = 0.016 < 0.05$) between the experimental and the control group. The gain score and post-test score of SMU and SMR on the experimental group that implemented the CGGD learning approach were significantly higher than the control group. Therefore, we conclude that the CGGD learning approach was proven influential to empower SMU and SMR.

2.4 Summary of Literature Review

The literature reviewed reveals that guided discovery method have pointed to the fact that attitude played a crucial role in learning mathematics hence determines the student's success in the subject. Research also supported the fact that a positive attitude towards the subject is an important educational outcome that should be constantly nurtured regardless of the achievement level of the learners who should be guided in order to bring out their best abilities and potentials. However, there has not been a consistent finding as to the relationships between attitudes and achievement and on a proper recommendation on how to positively change the attitudes for the benefit of the learners. Literature confirms that it should start from determining the root cause of attitudes and using that information to bring out the expected change which in most cases has remained elusive or not practicable in the school contexts. Bearing in mind various variables that play a role in determining the learner's attitude, the literature stresses the need for more understanding on the effect of these variables in the learning of the subject which has always received very little attention from the stakeholders. This study sought to create more awareness and understanding on the common beliefs among the students which affects the learning of the subject and suggest more recommendations for improvement in performance through attitude change. The low performance and little engagement in an academic work by the learners may imply that the attitude change has not succeeded or different variables are given priority since attitude is implicit, but should continue as an area of concern among all the stakeholders in education. This calls for a more concerted effort in order to change some of the student's beliefs regarding the nature of learning and the factors that affect it. It also necessitates the development of strategies in education contexts to improve student attitudes and engagement as well as improving on the teacher's supports system.

The review of literature also dealt with some theoretical and empirical studies. In the theoretical background, theory of constructivist and Ausbel's theory of meaningful learning, were reviewed. All these were discussed with regard to their relationship with the present study. The empirical studies gathered information on studies related to the present study. However none of these studies have investigated into the effect of guided discovery and graphical approaches on mathematics achievement and attitude of senior secondary school students in Minna, Metropolis, Nigeria, hence, the rationale for the study.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The research design that was adopted for this research was quasi-experimental design precisely (pre-test, post-test, non-equivalent) and descriptive survey design. This design involves three independent variables (Guided discovery, Graphical approach and Lecture method), two levels of dependent variables (achievement, attitude and gender). The design involves two experimental groups, group 1 were taught with guided discovery strategy, group 2 were taught with graphical approach and the control group were taught with conventional method. The research design layout is as shown in Figure 3.1:

Group		**Pretest**		**Treatment**		**Post-test**		**Attitude**
Exp. Gp 1	→	O_1	→	X_1	→	O_2	→	O_3
Exp. Gp 2	→	O_1	→	X_2	→	O_2	→	O_3
Control Gp	→	O_1	→	X_0	→	O_2	→	O_3

Figure 3.1: Research Design Illustration

Source: Sambo (2015)

Key:

O_1 Represents the pretest of experimental and control groups

O_2 Represents the posttest of experimental and control groups

O_3 Represents the post-posttest of experimental and control groups

X_1 Represents treatment for experimental group I on Guided discovery method

X_2 Represents treatment for experimental group II on Graphical approach

X_3 represents the control group exposed to lecture method

3.2 Population of the Study

The target population for the study comprises of all senior secondary two (SS2) students registered in government senior secondary schools located in Minna Education Zone. There are 115 secondary schools in the zone with the population of 3999 students (1641 Male and 2358 Female)

Source: Niger State Ministry of Education (2020).

3.3 Sample and Sampling Techniques

The sample of the study were 110 students from three randomly selected schools in Minna metropolis. Simple random technique was used in the selection of the three secondary schools from which were randomly assigned in the two experimental groups and one control group. Intact classes of the schools were used which were SS IIA of the three schools. The experimental group 1 comprised 30 students (13 males and 17 females). The experimental group 2 comprised 35 students (16 males and 19 females). The control group comprised 45 students (22 males and 23 females). This give the total sample of 110 students in the study.

3.4 Instrument for Data Collection

Two instruments were used for data collection namely; Mathematics Achievement Test (MAT) and Mathematics Attitude Rating Scales (MARS)

3.4.1 Mathematics achievement test (MAT)

The mathematics achievement test consisted of set of 30 multiple choice items designed to reveal the level of students understanding of the selected concepts in mathematics. The 30 multiple choice items consisted of five response option, one of which is the correct answer while the remaining four serve as distracters. The test items were in conformity with Bloom's taxonomy of the cognitive domain, i.e. knowledge, comprehension, application, analysis, synthesis and evaluation. The MAT was used as a pretest to determine the equivalence of the control and experimental groups and was also used as posttest to compare the groups for significant difference after the treatment.

Mathematics Achievement Test (MAT) was administered on the subjects by the research assistants and collected after twenty five minutes. While the control group was access with the same test used for the experimental groups at equal time, after which they were stopped. A marking scheme was used to score the responses to the MAT. A correct response was awarded one mark while any wrong response attracts zero. The total obtainable mark was thirty (30). The result of the test was converted 100%.

3.4.2 Mathematics attitude rating scales (MARS)

The second instrument referred to as Mathematics Attitude Rating Scales (MARS) it was developed by Richardson and Suinn (2009) and was adopted and used by the researcher with a view of generating responses on the attitudinal aspects of the study. The instrument consist of twenty items five point Likert scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). The responses were assigned weights of 5; 4; 3; 2 and 1 respectively for favorable statements. MARS was administered as a pretest and post-test to the control and experimental groups. This is to observe if there is any significance change in attitude based on the treatment administered. The response indicated the degree of attitude arouse by ticking any of the five point categories ranging from strongly agree (SA) =5 to strongly disagree (SD) =1, made available in the MARS instrument to determine the decision rule.

3.5 Validity of the Research Instruments

For the purpose of this study, experts in Mathematics education and measurement were consulted to carry out the validation of the instruments. The validators chosen include two experts in mathematics education in department of science education, Federal University of Technology, Minna and the teachers teaching the classes of the senior secondary schools of the affected school in Minna, Niger State. The team also includes two experts in Test and Measurement from Niger State College of Education, Minna. The test items examined by the experts were: Content validation, appropriateness of the items, clarity of the statements in the instrument, to ascertain whether the test items are related to concepts in SSII syllabus and to give suggestions and criticisms that would assist towards improving the quality of the test items.

3.6 Reliability of the Research Instrument

The reliability coefficient of a test refers to the consistency with which the test repeatedly measure what it is assumed to measure, after repeated use, if aside from a small margin of measurement error, if the results contained from a test are not different from each other, then such a test is said to be reliable (Sambo, 2015). In order to determine the reliability of the research instruments, a pilot study was carried out using 30 senior secondary school students. A test retest was used to determine the reliability of the instruments. Pearson Product Moment Correlation coefficient statistics was used to determine the reliability of Mathematics Achievement Test (MAT) and Mathematics Attitude Rating Scale (MARS) through pilot study. The same test was administered on two different occasions at two weeks interval as recommended by Sambo (2015) the scores from the two administrations was correlated as an estimate of the reliability of the of the test (Sambo, 2015). The reliability test using Kunder- Richard formula 21 and reliability coefficient obtained for MAT is 0.90 while the reliability for consistency MARS was computed using Cronbach Alpha Coefficient and reliability coefficient was 0.88.

3.7 Method of Data Collection

One week before the experiment, the researcher visited the selected schools in order to obtain official permission from the school management. Cooperation of staff was sought. One week was used for the administration of the pretest. This was done in order to determine the previous knowledge and the equivalent level of both the experimental and control groups. The actual teaching started on the second week. The experimental groups were exposed to content unit were richly supported with graph instruction material. The experimental group I and II were exposed to guide discovery and Graphical approach whereas the control group was taught using conventional lecture method. The same content unit was covered for the three groups. This exercise lasted for 5 weeks art contact period of once a week. At the end of the teaching posttest was administered to the three groups. Students were also be given attitude scale rating scale for their response after exposing them to the use of guided discovery method and Graphical approach. Data collection lasted for ten weeks.

BREAKDOWN

1st week……….Administration of pretest

2nd- 6th week ……..Main teaching

7th week…….Administration of posttest

8th-9th week ……….Break

10th week…………..post-post –test questionnaire to determine attitude after teaching

3.8 Method of Data Analysis

The data collected from sampled schools was analyzed using Descriptive statistics and inferential statistics. The descriptive (Mean and standard deviation) was used to answer research questions. The decision mean of 3.0 was used as items with weight mean of 3.0 and above was considered agreed and any item with weight mean less than 3.00 was considered disagreed as a decision rule for attitude rating. The inferential statistics, the analysis of variance (ANOVA) was used to test the null hypothesis one and three while t-test was used to test hypothesis two, four and five at 0.05 level of significant. The data was analyzed using statistical package for social science (SPSS) version 21.0.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Research Question One

What are the mean achievement scores of students taught Mathematics using guided discovery method, graphical approach and conventional method?

To answer this research questions, Mean and Standard Deviation was used as shown in Table 4.1.

Table 4.1: Mean and Standard Deviation of pretest and post-test Achievement scores of Experimental and Control group

		Pretest		Posttest			
Group	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**Mean Gain**	**Remark**
Guided Discovery	30	33.17	7.804	64.60	17.583	31.43	Positive achievement
Graphical approach	35	34.49	6.303	66.49	17.092	32.00	Positive achievement
Control group	45	32.93	9.955	62.42	19.971	29.49	Positive achievement
Total	**110**	**100.59**	**24.062**	**193.51**	**54.646**	**92.92**	

Table 4.1 revealed the mean achievement scores and standard deviation of students taught guided discovery, graphical approach and conventional method. The table showed that the mean achievement scores of the three groups at posttest differ statistically. Graphical approach had the highest mean achievement score of 66.49 with standard deviation 17.092 followed by guided discovery method which had mean achievement score of 46.60 with standard deviation of 17.583 while the control group had mean achievement score of 62.42 with standard deviation 19.971. There were mean different scores of 32.00, 31.43 and 29.49 respectively. This show that graphical approach enhanced better achievement of students than the guided discovery method and conventional method.

4.2 Research Question Two

What are the mean achievement scores of Male and Female students taught mathematics using guided discovery method?

To answer this research question, Mean and Standard Deviation was used as shown in Table 4.2.

Table 4.2: Mean and Standard Deviation of pretest and post-test Achievement scores of Male and Female guided discovery method

		Pretest		Posttest			
Group	N	$\overline{X}$	SD	$\overline{X}$	SD	Mean Gain	Remark
Male	13	34.21	15.398	74.71	12.298	40.50	Positive achievement
Female	17	30.98	41.906	65.48	16.147	34.50	Positive achievement
Total	**30**	**65.19**	**57.304**	**140.19**	**28.445**	**75**	

Table 4.2 showed that the mean and standard deviation of the pretest and posttest score of male and female students taught using guided discovery method. The result revealed that the mean and slandered deviation of pretest and posttest scores of Male students was 34.21 with standard deviation of 15.398 and 74.71 is the mean score of Male students at posttest with 12.298 standard deviation respectively. The mean gain for Male students in guided discovery method is 40.50. Similarly the mean and standard deviation of the pretest and posttest scores of Female students was found to be 30.98 with standard deviation of 14.908 at pretest and posttest mean score of 65.48 and standard deviation of 16.147 was obtained by Female students the mean gain of Female students in guided discovery is 34.50 this implies that male students had higher mean gain than the Female students in the same group.

4.3 Research Question Three

What is the mean achievement scores of Male and Female students taught Mathematics using graphical approach?

To answer this research question, Mean and Standard Deviation was used as shown in Table 4.3.

Table 4.3: Mean and Standard Deviation of pretest and post-test Achievement scores of Male and Female graphical approach.

		Pretest		Posttest			
Group	**N**	$\overline{X}$	**SD**	$\overline{X}$	**SD**	**Mean Gain**	**Remark**
Male	16	35.05	1.25	80.26	9.22	45.21	Positive Achievement
Female	19	34.58	1.49	78.70	8.45	44.12	Positive Achievement
Total	35	69.63	2.74	158.96	17.67	89.33	

Table 4.3 showed that the mean and standard deviation of the pretest and posttest scores of Male and Female students taught using graphical approach. The result revealed that the mean and standard deviation of pretest and posttest scores of Male students was 35.05 mean with standard deviation of 1.25 and 80.26 is the mean with 9.22 standard deviation for Male students in graphical approach and the mean gain is 45.21. Similarly, the mean and standard deviation of the pretest and posttest scores of Female students was found to be 34.58 with standard deviation of 1.49 at pretest while posttest mean score of 78.70 with standard deviation of 8.45 was obtained by the Female students. The mean gain of Female students in graphical approach was 44.12. This implies that Male students had higher main gain than the Female students in the same group.

4.4 Research Question Four

What is the attitude of senior secondary school students toward the use of guided discovery method, graphical method and conventional method?

To answer this research question, Mean and Standard Deviation was used as shown in Table 4.4.

Table 4.4: Mean and Standard Deviation of attitude of responses of students after teaching them with guided discovery, graphical approach and conventional method

Group	N	Mean ($\overline{X}$)	SD	Remark
Guided Discovery	30	126.97	14.221	Positive attitude
Graphical Approach	35	112.83	25.018	Positive attitude
Conventional method	45	121.07	22.766	
Total	**110**	**360.87**	**62.005**	

Table 4.4 reveals the mean attitude score and standard deviation of students in experimental I (Guided Discovery), experimental II (Graphical Approach) and control group (Conventional method). The table showed that the mean attitude score of the three groups differ statistically. Guided discovery method had the highest mean attitude score of 126.97 with standard deviation of 14.221, by followed by conventional method which had mean attitude score of 121.07 with standard deviation of 22.766 also graphical approaches which had mean score of 112.83 with standard deviation of 25.08. This shows that guided discovery method have positive attitude towards mathematics in solving quadratic equation compared to other method used in teaching quadratic equations.

4.5 Research Question Five

What is the attitude of Male and Female senior secondary school students to Mathematics after taught with the guided discovery method?

To answer this research question, Mean and Standard Deviation was used as shown in Table 4.5.

Table 4.5: Mean and Standard Deviation of Male and Female Senior Secondary School Students Attitude to Mathematics after taught with the Guided Discovery Method

Group	Gender	N	Mean ($\overline{X}$)	SD	Mean Gain	Remarks
Guided Discovery	Male	13	128.86	6.31		
					9.64	Positive attitude
	Female	17	126.39	15.95		

Table 4.5 showed that the mean and standard deviation of the pretest score of male and female students taught using guided discovery method. The result revealed that the mean and standard deviation of male was 128.86 with standard deviation of 6.31 while mean and standard deviation of female was 126.39 with standard deviation of 15.95. The mean gain was 9.64.

4.6 Research Question Six

What is the attitude of Male and Female senior secondary school students to mathematics after taught with the graphical approach?

To answer this research question, Mean and Standard Deviation was used as shown in Table 4.6.

Table 4.6: Mean and Standard Deviation of Attitude of Male and Female Senior Secondary School Students Attitude to Mathematics after taught with the Graphical Approach

Gender	N	$\bar{X}$	Std. Deviation	Mean difference	Remark
Male	16	113.50	24.75	1.15	Positive attitude
Female	19	112.26	25.90		
Total	**35**	225.76	50.65		

Table 4.6 shows the mean and standard deviation on how gender influences the perception of mathematics students' response based on graphical approach. The result indicates that the mean and standard deviation of the two groups differ with a mean score of 80.81with standard deviation of 8.11 for male students and mean score of 80.11 with standard deviation of 8.33 for female students. The mean difference of 0.70 is in favour of the Male students.

4.7 Hypotheses Testing

The data collected in order to test the mull hypothesis one was analyzed using Analysis of Variance which is reported in Table 4.7.

Table 4.7: ANOVA comparison of the Pretest mean scores of the Experimental and Control group

Source of Variation	Sums of Square	df	Means Square	F_{cal}	P-value	Decision
Between Groups	51.781	2	25.891			
Within Groups	7477.710	107	69.885	0.370	0.691	NS
Total	7529.491	109				

Not significant at 0.05 level.

Table 4.7 shows the result of one-way ANOVA comparison of the mean achievement scores of students in the two experimental groups and the control group at pretest. The result revealed that there was no significant difference in the achievement of students in the three groups (F_{cal} = 0.370; df = 109; $p>0.05$). This showed that the students entry level was equivalent and that calls for the use of Analysis of Variance in testing the hypotheses.

HO_1: There is no significant difference between the mean achievement scores of students taught Mathematics using guided discovery, graphical approach and conventional method.

In testing the hypothesis one; the mean achievement scores of students taught Mathematics using guided discovery, graphical approach and conventional method were analyzed using Analysis of Variance (ANOVA) as shown in Table 4.8

Table 4.8: ANOVA Comparison of the Posttest Mean Scores of the Group I and II and Control Group

Source of Variation	Sums of Squares	df	Means Square	F	P-value	Decision
Between Groups	328.570	2	164.285			
Within Groups	36446.921	107	340.625	0.482	0.619	NS
Total	36775.491	109				

Not significant at 0.05 level.

Table 4.8 shows the ANOVA result of the comparison of the posttest mean scores of the experimental group 1, experimental group 2 and control group. An examination of the table shows Fcal=0.482, df=109 and $p>0.05$. On the basis of this hypothesis one was retained. There. Therefore, there was no significant difference in the mean achievement scores of guided discovery, graphical approach and control group. Post-hoc was carried out to locate where the significant difference exits as presented in Table 4.9.

Table 4.9: Scheffe Post-hoc Analysis of Comparison of the Post-test of Experimental I, II and Control Group

Treatment (i)	Treatment (j)	Treatment (i-j)	p-value	Lower bound	Upper bound
EXP I (GD)	CG	2.178	0.871	-8.16	12.52
	GA	-1.1886	0.911	-12.80	9.03
EXP II (GA)	GA	4.063	0.593	-5.82	13.95
	GD	1.886	0.911	-9.03	12.80
Control Group	GD	-2.178	0.871	-12.52	8.16
	GA	-4.063	0.593	-13.95	5.82

Table 4.9 showed that post-hoc analysis of comparison of the posttest mean scores of the experimental I, experimental II and control group. The table indicated that significant difference exist among the mean achievement scores of students in experimental I, experimental II and control group.

HO_2: There is no significant difference between the mean achievement scores of Male and Female students taught Mathematics using guided discovery method.

In testing the hypothesis two; the mean achievement score of Male and Female students taught using guided discovery method were analysed using t-test statistics as shown in Table 4.10.

Table 4.10: Summary of t-test Comparison of the Mean Achievement Scores of Male and Female Students taught using Guided Discovery Method

	Gender	N	X	SD	Df	t	p-value	Mean diff	Decision
Prestest	Male	13	35.00	3.958	28	0.352	0.727	1.04	
	Female	17	33.96	7.462					NS
Posttest	Male	13	74.71	12.298	28	1.389	0.176	9.23	
	Female	17	65.48	16.147					

Not significant at 0.05 level.

Table 4.10 revealed the mean achievement scores of Male and Female students taught Mathematics using guided discovery method. The table indicated that there was no significant difference between the mean achievement of students taught guided discovery method since p>0.05 level of significance (p<0.176), an indication that the approach benefited both male and female students in the experimental group I. thus, hypothesis two is retained.

HO_3: There is no significant difference between the mean achievement scores of Male and Female students taught Mathematics using graphical approach.

In testing the hypothesis three, the mean achievement scores of Male and Female students taught using graphical approach were analysed using t-test as shown in Table 4.11

Table 4.11: Summary of t-test Comparison of the Mean Achievement Scores of Male and Female Students taught using Graphical Approach

	Gender	N	$\overline{X}$	SD	Df	T	p-value	Mean diff	Decision
Prestest	Male	16	36.31	6.172	33	1.610	0.117	3.36	
	Female	19	32.95	6.151					Sig
Posttest	Male	16	68.06	17.391	33	0.495	0.624	2.90	
	Female	19	65.16	17.196					

Significant at 0.05 level.

Table 4.11 showed the t-test comparison of the mean achievement scores of male and female students taught mathematics using graphical approach. The Table indicated that there was no significant difference since p>0.05 level of significance (p<0.624), an indication that the instrument benefited both male and female students in the experimental group II. Thus, hypothesis three was rejected.

HO_4: There is no significant difference amongst the attitude of students taught mathematics using guided discovery, graphical approach and conventional method.

In testing the hypothesis four, Analysis of Variance (ANOVA) was used as shown in Table 4.12.

Table 4.12: Summary of ANOVA Comparison of the Attitude of Students taught Guided Discovery, Graphical Approach and Conventional Method

Source of Variation	Sums of Squares	df	Means Square	F	P-value	Decision
Between Groups	3306.935	2	1653.467			
Within Groups	49950.738	107	466.829	3.543	0.032	NS
Total	53257.673	109				

Not significant at 0.05 level.

Table 4.12 shows the ANOVA result of the comparison of attitude score of guided discovery, graphical and conventional method. An examination of the Table shows F_{cal} = 3.543l df=109; and p<0.05. On the basis this; hypothesis four was rejected. Therefore, there was significant difference in the attitude of students taught Mathematics using guided discovery, graphical approach and conventional method. As such, Scheffe post-hoc was carried out to locate where the significant difference exists as presented in Table 4.13.

Table 4.13: Scheffe Post-hoc analysis of the Posttest attitude of students Experimental I, II and Control group

Treatment (i)	Treatment (j)	Treatment (i-j)	p-value	Lower bound	Upper bound
EXP I (GD)	CG	5.900	0.481	-6.20	18.00
	GA	14.138*	0.026	1.36	26.92
EXP II (GA)	CG	-8.238	0.213	-19.81	3.34
	GD	-14.138*	0.026	-26.92	-1.36
Control Group	GD	-5.900	0.481	-18.00	6.20
	GA	8.238*	0.213	-3.34	19.81

Table 4.13 showed that the Sheffe post-hoc analysis of attitude of students in experiment group I, experiment group II and the control group. The Table indicated that significant difference exist among the attitude of students in experimental group I, experimental group II (mean difference = 14.138) with an upper bound of 26.92 was obtained. It also showed that significant difference exists between experimental group II and control group (mean difference = -8.238) with an upper bound of 3.34 in favour of guided discovery method. This implies that students who used guided discovery have positional attitude better than those who used graphical and control group.

HO$_5$: There is no significant amongst the attitude of Male and Female senior secondary school student taught with guided discovery.

In testing the hypothesis five, t-test was used as shown in Table 14.

Table 4.14: Summary of t-test Comparison of the Mean Achievement Scores of the Attitude of Male and Female Students taught with Guided Discovery Method among Senior Secondary Schools in Minna.

Gender	N	Mean ($\overline{X}$)	Std. Deviation	t-value	df	Sig.
Male	7	128.86	6.309	0.396	28	0.69
Female	23	126.39	15.945			

Table 4.14 shows the t-test results on the comparison of mean achievement scores of the attitude of male and female students taught with guided discovery method among senior secondary school in Minna. The result indicates t= 0.396. Df= 28, p = 0.69 > 0.05. The result shows that there was no significant difference in the achievement of male and female students taught guided discovery method. On this basis, hypothesis five is therefore retained.

HO$_6$: There is no significant difference between the attitude of Male and Female senior secondary school student taught with graphical approach.

To test the hypothesis, t-test comparison of the mean achievement scores of the attitude of Male and Female students with graphical approach among senior secondary school in Minna which is reported in Table 4.15.

Table 4.15: Summary of t-test comparison of the mean achievement scores of the attitude of Male and Female students taught with graphical approach among senior secondary school in Minna.

Gender	N	Mean ($\overline{X}$)	Std. Deviation	t-value	df	Sig.
Male	16	113.50	24.752			

				0.144	33	0.887
Female	19	112.26	25.905			

Ns= Not Significant at 0.05 level

Table 4.15 shows the t-test results on the comparison of mean achievement scores of the attitude of male and female students taught with graphical approach among senior secondary school in Minna. The result indicates t= 0.144, Df= 33, $p < 0.887 > 0.05$. The result showed that there was no significant difference in the achievement of male and female students taught graphical approach. On this basis, hypothesis six is therefore retained.

4.4 **Summary of the Findings**

From the data collected, computed, analyzed and interpreted in this study, the findings are summarized as follow:

1. Finding from research question one revealed that graphical approach enhanced better achievement of students than the guided discovery method and conventional method.
2. Finding from research question two revealed that had higher achievement score than their female counterparts taught using guided discovery.
3. Finding from research question three revealed that male had higher achievement score than their female counterparts taught using graphical approach.
4. Finding from research question four revealed that students showed positive attitude when taught using guided discovery method.
5. Finding from research question five revealed that male students showed positive attitude towards learning mathematics concept using guided discovery.
6. Finding from research question six revealed that male students showed positive attitude towards learning mathematics concept using graphical approach
7. There was significant difference in the achievement of students taught guided discovery method and those taught using conventional method.

8. There was no significant difference in the mean achievement of students taught guided discovery method and graphical approach.
9. There was no significant difference in the achievement of male and female students taught guided discovery method
10. There was no significant difference in the achievement of male and female students taught using graphical approach. On this basis, hypothesis one is therefore retained.

4.4 Discussion of Findings

Finding from research question one revealed that graphical approach enhanced better achievement of students than the guided discovery method and conventional method. This finding is in line with the earlier findings of Clute (2011), who found that graphical approach is important in promoting learning with young children and discovered that students are better motivated by an active approach. In agreement with Yapwi (2015) discovery was seen as intrinsically rewarding for students, so that the teachers using discovery methods should have little needs to use extrinsic form of reward. Supported by Thomas and Lasisi (2015) whose study investigated effects of guided discovery and problem solving instructional strategies on achievement of secondary school students in volumetric analysis and discovered that students taught with guided discovery method have higher mean achievement scores in chemistry than their counterparts taught chemistry with conventional teaching method, hence guided discovery and problem solving strategies have enhanced achievements in chemistry more than traditional method of teaching.

Findings on graphical approach in teaching mathematics among senior secondary schools enhance learning. Mega (2014) opined that when mathematics talk about graphs they are mostly likely to be thinking of collection of dots and lines that you see in the illustration of the study. In the present study, the graphical approach shows significant difference among other methods used in teaching quadratic equations. In line with findings Walle (2010) suggested that teachers should not get overly anxious about the tedious details of graph construction.

Teachers should take one or two approaches to graph construction. Richard (2016), view model as being a representation as it arouse students intention towards learning. Furthermore, simple interaction with model provides a far more interesting exercise than observation and conclude by saying that graphical symbol model serves as a tool in ratio learning and bring interaction stimulation on the pupils and create more interesting exercise than through observation and passively. Findings that emanated on the attitude of senior secondary school students towards the use of guided discovery and graphical approach in teaching quadratic concept. It was revealed that much interest were placed during the teaching and learning process as the mean achievement scores showed little differences when compared.

Hypothesis one finds out if there was no significant difference between the mean achievement score of student taught Mathematics with the use of guided discovery, graphical approach and those taught with conventional method among senior secondary school in Minna. The result revealed that there was no significant difference in the achievement of students taught guided discovery method and those in control group (conventional method). On this basis, hypothesis one is therefore rejected. This implies that students found teaching quadratic equation interesting than the use conventional method. Mayer (2015) claimed to have established that guided discovery was the best method to promote the learning of certain rule. Thomas and Lasisi (2015) argued that guided discovery only looked better because of what it had been compared with, usually-rote learning. He went further to claim that there was just no evidence that discovery of any kind was more effective teaching method than meaningful exposition.

Hypothesis two finds out if there is significant difference in the mean achievement score of Male and Female student taught Mathematics with use of guided discovery method and those taught with graphical approach among senior secondary school in Minna The result revealed that there was no significant difference in the mean achievement of students taught guided discovery method and graphical approach. On this basis, this hypothesis is therefore retained This implies that both guided discovery and graphical approach signifies the reason why students should be exposed to experimental group as there were slight difference in their mean achievement score.

Hypothesis three finds out if **t**here is significant difference in the mean achievement score of Male and Female student taught Mathematics with use of graphical teaching approach and those taught with conventional method among senior secondary school in Minna. The result revealed that there was no significant difference in the mean achievement of students taught graphical approach and those in control group (conventional method). On this basis, this hypothesis is therefore retained. This implies that students exposed to experimental group do better than those taught through conventional method of teaching. This shows that there is a connection/link between teaching-learning, achievement and methodology in shaping the learners in science (Iwuji, 2012). Graphical approach teaching strategy makes the learner to construct his own knowledge to be used in later age; so teachers should pick from the science curriculum topic that involves activities for the learners to discover solution themselves and teachers are expected to guide them. In graphical approach teaching strategy students has the opportunity to work with graph and mathematical set materials and engaged in activities, which enhanced meaningful learning and reduces abstract nature from concepts and provide a motivating environment for learning (Iwuji, 2012).

Hypothesis four finds out there is significant difference in the in the attitude of secondary school students taught with guided discovery method, graphical approach and conventional method. The result showed that there was no significant difference in the attitude of students taught guided discovery method, graphical approach and control group. On this basis, this hypothesis is therefore retained. Obodo (2015) stated that students attitude towards mathematics are much related to their attitudes towards problem solving in general and that negative attitude need to be overcome so that later in life students will not suffer from poor problem-solving skills. Adebule *et al.* (2016) was categorically emphasized about attitude and commented that there was no special gift or qualities of mind to learn mathematics. It is stressed that the subject is within the grass of anyone. This attitude of pupils who are incapable of performing well in mathematics can hence be related to their wellness to choose, to grasp or not to grasp the subject.

Hypothesis five finds out if there is significant difference in the in attitude of Male and Female senior secondary school student taught with guided discovery method. The result showed that there was no significant difference in the achievement of male and female students taught graphical approach. On this basis, this hypothesis is therefore retained. This finding is in line with Iwuji (2012) whose findings of implies that the level of achievement of the male students exposed to Activity-Based teaching experiences is the same with their female counterparts. The result indicated that the Activity-Based teaching strategy is gender friendly. This finding agrees with the findings of Iwuji (2012) who said understanding and retention are products of meaningful learning, when teaching is effective and meaningful to the students whether male or female. Thus, meaningful learning is the product of students' involvement in act of learning like in Activity-Based teaching strategy. Also found that the type of instructional strategy used does not discriminate between male or female. Therefore, the Activity-Based teaching strategy is gender friendly as far as this study is concerned. Concrete and meaningful learning appears to be gender-friendly.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings from the analysis of the data collected for this study, the following conclusions was made: Graphical approach enhanced better achievement of students than the guided discovery method and conventional method, students showed positive attitude when taught using guided discovery method, Male students showed positive attitude towards learning mathematics concept using guided discovery than their female counterparts and male students showed positive attitude towards learning mathematics concept using graphical approach than their female counterparts.

Therefore, a way of ensuring an improved performance of the learners during the external examination is by making them appreciate the inter-dependent relationship that exists between academic contents of mathematics concepts presented in the teaching and learning situations while in school and their real life applications (graphical approach). If we are able to achieve this transfer of what is learnt in school to the real-world then improved achievement in external examination, irrespective of gender, can be achieved.

5.2 Recommendations

Based on the findings of the study, the following recommendations were made:

1. The Government through the Federal and State Ministries of Education should organize and sponsor mathematics teachers for workshops, exhibitions, quizzes, seminars and conferences on a regular basis aimed at upgrading the knowledge status of the teachers.
2. Mathematics teachers should endeavor to use the graphical approach teaching strategy in teaching equations both linear and quadratic and some other Mathematics concepts that are tagged “difficult” since this method enhances achievement and has the potentials of developing critical thinking and creative abilities in the students.
3. Students should be serious, hardworking, initiative and creative to enable them carryout independent or group work, such as assignments or project given to them by the mathematics teachers.

5.3 Contribution to Knowledge

The present study has greatly contributed to the field of study; exposing the significance of guided discovery instructional approach as compared with the graphical symbol and conventional method of teaching. The significance of guided discovery instructional approach was proven to improve positive attitude of secondary school student towards studying Mathematics. Finally, the guided discovery instructional approach was not gender biased.

5.4 Limitations for the Study

The following limitations were encountered during the study:

1. Students absence were major concern of the researcher and the few ones present were so difficult to control by their teachers which could also in one way or the other affect the outcome of the result
2. Students' lack of familiarity with graphical and discovery approach may affect the results. This is a limitation because plotting graph is one of the most student centered teaching strategies where students are given a big role in their own learning. This transfer of roles may need more time to settle into the students' learning styles. This problem was minimized by introducing the method to the students to the beginning of the term. This ensured a smooth transition to instruction.
3. The study is only restricted to only senior secondary school students in Minna metropolis. This might make the scope of generalization fairly narrow.
4. The study only used the quadratics equations concept in senior secondary school Curriculum.

5.5 Suggestions for Further Studies

The following suggestions were made for further studies in this area.

1. Similar studies should be conducted in senior secondary schools in other local government to find out the effects of graphical approach with other teaching strategies on students academics achievement in large classes and their retention.
2. The study can be replicated to include motivation and interest of students towards the use of guided discovery method.
3. The study should be replicated in other fields of study.

REFERENCES

Abu –Hilal, G. (2012). Neuroticism , extraversion and academic achievement as related to gender and culture. *Indian Psychology Journal, 54*(1-2), 74-78.

Adebule, S.O., Onijigin, E.O., Balogun, E.A. & Adebule, H.T. (2016). An evaluation of low and high achievements in mathematics in Ekiti state secondary schools. *Journal of Educational Policy and Entrepreneurial Research (JEPER)*, 3(6), 9-20

Adegoke, F., Mustapha, B., Daikwo, D. & Acholo, P (2015). Student attitudes towards learning technology in nigeria university: A descriptive analysis. *International Journal of Engineering Research*. 4. 2277-5668.

Adetula, L. O & Ale S. O. (2015). Potential generator of interest in mathematics. reflective and intellective *position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.*

Aguele, L.I. & Agwagah, U.N.V. (2014). Female participation in science, technology and mathematics, (STM) education in Nigeria and national development. *Journal of Social Science*, *15*(2), 121-126.

Agwagah U. N. V. & Gimba, R. W. (2013). Effect of computer assisted instruction package on students' achievement in mathematics set theory. *Review of education,* 24(1), 103-114.

Ajai, J.T. & Imoko, I.I. (2015). Gender differences in mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science (IJRES), 1*(1), 45- 50.

Ajogbeje, J. & Alonge, F. (2012). Effect of feedback and remediation on students' achievement in junior secondary school mathematics. *International Education Studies*, 5(5), 28-36.

Akinoso, S. O., (2013). Correlates of some factors affecting students' achievement in secondary school mathematics in Osun state, *Nigeria. International Journal of Education, Science, Mathematics and Environmental Studies, 3(1) 83-95.*

Alesandrini, K. (2012). The new objects spatial-verbal cognitive style model. Httpwww.doi.wihey.com htlm.

Ali, A. A. (2010). "Teachers production utilization and turnover patterns in nigeria" in Kabiru Isyaku et al (Ed) Teachers Production Utilization and Turnover Pattern in Nigeria Kaduna: N.C.C.E.

Allen, B. (2013). Mathematics modelling: visual perception in relation to level or meaning for children. http://www.digital.Cibrary.Cent.education/Permallink/meta.dc-3896:Lhtlm.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*, Arlington: American Psychiatric Publishing, 190; 197–202.

Aremu, A.O., & Oluwole, D.A. (2011). Gender and birth order as predictors of normal pupils' anxiety pattern in examination. *Ibadan Journal of Educational Studies, 1*(1), 1-7.

Audu, M. S. (2010). Mathematics-an essential tool for universal basic education (ube) "implication for secondary education" MAN presidential address at the opening ceremony of the 38th Annual National Conference of Mathematical Association of Nigeria held at Hassan Usman Katsina Polytechnic, Katsina

Audu, M. S. (2011). Mathematics and science development in the 21stcentury. a paper presented at the first national sum it in mathematical sciences; National Mathematical Center Abuja.

Audu, M. S. (2015). Application of mathematics: *reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.*

Ausbel, D. P. (1968). *Educational psychology: A cognitive view*. New York; Holt.

Ayla, A. (2015). Mathematical Modelling Approach in Mathematics Education. *Universal Journal of Educational Research* 3(12): 973-980

Baber, R.L. (2011). *The language of mathematics: utilizing math in practice*. John Wiley & Sons.

Badmus, G. A. (2012). Interest and attitudes as correlates of mathematics achievement of secondary school students. Un-Published Paper. Faculty of Education, University of Benin.

Badmus, G. A. (2015). Improving positive attitudes and interests of students to mathematical science. reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Bature, I. J. (2013). Effect of state qualifying examination on student's performance in ssce in some selected secondary schools in Adamawa State. *Standardized of The Nigerian Academics* 2(2), 43-51.

Bello, S. A. (2011). A study of relationship between instructional methods, anxiety and students achievement in mathematics in junior secondary schools. Unpublished Med Thesis at Mathematics Education Department, ABU Zaria.

Bolaji, C. (2015). Effect of three instructional approaches on students‟ achievement in algebra and word problem in junior secondary school Unpublished Phd Thesis, University of Nigeria, Nsukka.

Borne. S (2010). Developing model based reasoning Mathematics and Science. http.www.inkinghub.elsevir.com/retrieve/phi/80/9339739900490.

Bruner, J. (2009). Discovery learning (Bruner) Learning Theory. http://www.learningtheories.com/discovery learning-bruner.htr (2018)

Buschang, R. E., Chung, G. K. W. K. & Kim, J. (2011). An exploratory study of the relationship between collaboration and mathematics and game outcomes. *National Center for Research on Evaluation, Standards, and Student Testing (CRESST) Report 797*, Los Angeles, CA

Cameson, M. B. & Wilson, B. J. (2011). Effect of chronological age, gender and delay of entry on academic achievement and retention. implication for academic redshirting. *Psychology in the Schools, 3*(27), 260-263.

Capuno, R., Necesario, R., Etcuban, J. O., Espina, R., Padillo, G. & Manguilimotan, R. (2019). Attitudes, study habits, and academic performance of junior high school students in mathematics. *International Electronic Journal of Mathematics Education*, 19(3), 27-35.

Clute, P. S. (2011). Mathematics anxiety, instructional method, and achievement in a Survey course in college mathematics. By Pamela S. C, University of California, Riverside. *Journal for research in mathematics education,* 15(1), 50-58.

Cooney, T. (2012). Mathematics education dialogues: what motivate teachers to enter and remain in the profession? *A Publication of the NCTM*; 5(2), 110-119

Crow, L.D & Crow (2011). *Adolescent development and adjustment.* USA: Mc Grow-Hill Book Company.

Druger, M. (2012). It All Depends: *Journal Of College Science Teaching, 31(7) 493-495.*

Ebong, J. M & Agabi C. O. (2015). Sourcing of resources for the secondary school system in Nigeria; *Nigerian Journal of Curriculum Studies. Nigerian Educational Research and Development Council Sheda Abuja 12(1).* 110 -218

Effandi, Z. & Normah, Y. (2009). Attitudes and problem-solving skills in algebra among Malaysian College Students. *European Journal of Social Sciences*. 8, 232-245.

Effiong, U. U. (2012). Science classroom environment factor cognitive preferences and achievement in physics-among senior secondary school students in Cross River State. An Unpublished Ph D Thesis University Calabar.

Egbule, J.F. (2014). *Practical guide to a successful project or thesis in writing and defence.* Owerri: Whyte and Whyte Publishers.

Emah, I. E. (2015). Questioning Interactions in Social Studies Classroom; *Nigerian Educational Research and Development Council Sheda Abuja. 12(1).154*

Emmanuel C (2013). Impact of audio-visual aids in teaching of mathematics. Unpublished undergraduate project University of Nigeria, Nsukka.

English L.D. & Halford G.S, (2012). Handbook of instructional mathematics. Research education books.httpwwwboooks.google-16Za/books.htlm.

Eniayeju, A. A. (2015). Training and retraining mathematics Teachers in Nigeria: Reflective and Intellective Position Papers on Mathematics Education Issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Eshiwani, G. (2011). Mathematics education around the world, bridging policy and practice: the role of algebra in the middle and secondary mathematics curriculum. *A paper presented at an International Seminar in Park City Mathematics Institute*, Utah USA, 19th -23rd July.

Etuk, N. E. (2015). Integrating ratiocination as instructional strategy for effective science teaching: *Nigerian Journal of Curriculum Studies. Nigerian Educational Research and Development Council Sheda Abuja 12(1).* 118

Eze, V. O. (2015). Gender and area of specialization as determinants of university of nigeria undergraduates' attitude towards the use of english. *International Journal of Humanities & Social Science Studies*, *1*(1), 123- 135.

Federal Republic of Nigeria (2013). *National Policy on Education* (forth Edition, Abuja Federal Ministry of Education.

Foley, A. E., Herts, J. B., Borgonovi, Guerriero, S., Levine, S. C., &Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science*, 26, 52-58.

Fox, M. (2015). Learning Design and E-Learning and EPIC White Paper. EPIC Group Plc Brighton.

Gafoor K. A. & Kurukkan A., (2015).Why high school students feel mathematics difficult? An exploration of affective beliefs. Paper presented at UGC Sponsored National Seminar on Pedagogy of Teacher Education- Trends and Challenges at Farook Training College, Kozhikode, Kerala.

Gagne, R. (2014). Apply learning theories to online instructional design. Soakmyung Women University press Seoul.

Gallenstein, N. L. (2013). Creative discovery through classification. *Teaching Children Mathematics*. 11; 103-114.

Ganiyu, A. B. (2015) Improving positive attitudes and interest of students to mathematical science. (*Reflective and Intellective Position Papers on Mathematics Education Issues. Published 2005 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.*

Gasca, A.M. (2011). Mathematicians and the nation in the second half of the nineteenth century as reflected in the Luigi cremona correspondence. *Science in Context*, 43-72.

Geary, D. C. (2013). Early foundations for mathematics learning and their relations to learning disabilities. *Current Directions in Psychological Science*, 22(1), 23–27.

Goolsby, L. (2013). *School Interest.* Boston: Allyn and Bacon.

Gushen, J. (2011). The information technology in education. a challenge for classroom teachers COEASU *Journal F. C. E. Pankshin.* 1(1), 16-24.

Hamm, A.O. (2009). *Specific phobias*. The Psychiatric Clinics of North. EPIC Group Plc Brighton

Hannah, B. N. (2015). Factors affecting performance in shorthand in secretarial studies programmes. *Nigerian Journal of Curriculum Studies,* 12(1), 19-27.

Harbor-Peters V. F. (2015). Attitudes and interest of students of the mathematical science in nigeria. reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Harbor-Peters, V. F. (2011). Unmasking aversion aspect of schools mathematics and strategies for averting them. Snapp Press Ltd.

Hartshrn, R. (2011). How learning theory support the use of manipulatives. httpwwwetacuisenair.Com/pdf/benefit of manipulatives.pdf.htlm.

Hidayati, N A., Fahmi, S. & Farida, K. (2018). The comparative of mathematics learning using guided discovery method and expository method to mathematics learning outcomes. *Journal of Physics: Conference Series,* 1321; 1-7

Holland, D. (2012). Modeling in Mathematics learning approaching for classroom of future. httpwwwmath.a.c.Ugljk.php.htlm.

Hopkins, M. T. (2012). The effect of computer based expository and discover method of instruction on aural regionition of concepts. *Journal of research in music Education*, 50; 131-33.

Howden W. (2015). Experimental learning of mathematics using manipulatives. http www. Eric digests. Org/pre. 9217/Math.htlm.

Ibok, M. S. (2012). Effect of Resources Management, Students‟ Attitude to Learning and Academic Achievement. An Unpublished M.Ed Thesis Faculty of Education, University of Uyo.

Idigo, E.C. (2010). Effective method of retaining students interest in mathematics in secondary schools in enugu east local government area of Enugu State, Unpublished UG Thesis, Institute of Ecumenical Education, Thinker’s Corner, Enugu, in Affiliation with (ESUT), Enugu.

Ihechukwu, N. B. &Ugwuegbulam, O. C. (2016).Causes and solutions of mathematics phobia among secondary school students. *Research on Humanities and Social Sciences*, 5(4), 19-24.

Irvin, H. B. (2011). EPSY 490 classroom learning and management (CTER) The *Journal for Research in mathematics education @1984 National Council of Teachers of Mathematics*. http://tip.psychology.org.bruner.html

Iwuji, N. P. (2012). Effects of activity-based teaching strategy on academic achievement and retention in basic science concepts among junior secondary school students. Unpublished M.ED Thesis. Ahmadu Bello University, Zaria. Kaduna.

Johnson-Laird (2015). Mental model towards a cognitive Science of language. http www jime.open.ac.uk.com.htlm.

Lassa, P. N. (2014). Production and retention of mathematics science teachers for nigerian education system (1). reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Lawal, O., Adetula, L. O. & Ale S. O. (2011). Potential generators of interest in mathematics. Relative and intellective position papers on mathematics education issues ISBN 978-35488-7-x printed by Marvelous Mike Vensures Ltd No 7 Abeokwuta street, of Ogbomoso Street Garki Abuja.

Lent, C. (2010). Urban-rural differences in academic achievement and academic related factor. *Journal of Education Research 25*(3), 121-129.

Lesh, R.A. (2014). Beyond Constructivism Models and modelling perspectives. http wwwgooglebooks.co zal books htlm.

Lillias, H. N. M. Jane, T. & Conilius, J. C. (2020). Exploring the conceptual understanding of the quadratic function concept in Teachers' Colleges in Zimbabwe. *EURASIA Journal of Mathematics, Science and Technology Education*, 16(2), 1-17

Lowrie, T. (2011). The influence of visual representation on mathematical problem solving and innumeracy performance. B. *Perry Journal of Education on innumeracy and beyond*, 2(3), 45-56.

Maikudi, J. (2015). Effect of guided-discovery and problem-solving strategies on attitude and performance towards geometry among junior secondary school students in Kaduna state, Nigeria. Unpublished Med project department of science education, University of Nigeria, Nsukka.

Mayer, R. E. (2015). Learning and. pearson education, Inc: upper Saddle, River 287-88.

Mbakwem, J. D. & Mkpa, M. A. (2013). Effect of cognitive styles and instructional strategies on students achievement in social studies. *The Educational Psychologist 1(1) pp122-193.*

Mega Mathematics (2014). Mathematics tools discussion: All topics in discrete mathematics. httpwww.Org/mathtools/discussion.htlm.

Miheso, K.M. (2012). *Factors affecting mathematics performance among secondary school students in Nairobi Province, Kenya.* Unpublished PhD Thesis, Kenyatta University. Retrieved from http://ir-library.ku.ac.ke/etd/handle/123456789/2485

Nguyen, K. T., Duong, T. M., Tran, N. Y., Ha, A. T., & Phung, Y. T. (2019). The impact of emotional intelligence on performance: a closer look at individual and environmental factors. *The Journal of Asian Finance, Economics and Business*, 7(1), 183-193.

Niger State Ministry of Education (2020). Records of secondary schools in Minna, Niger State.

Nor, F.M., Aziz, M.A. & Jusoff, K. (2011). Should English for teaching mathematics and science (ETeMS) in Malaysia be abolished? *World Applied Sciences Journal 12 (Special Issue on Creating a Knowledge Based Society)* 36-40.

Norman, H.A. (2015).Teaching children Mathematics. http.www.questia.com/ Library.book.htlm.

Nwosu, A. A. (2015). Constructivism as an innovative model of science teaching importance and extent of use in secondary schools. *Journal of the Science Teachers Association of Nigeria*, 7(3), 58 – 97.

Nwoye, M. N. (2011). Effect of graphical-symbol approach on the pupils achievement and interest in the teaching of ratio at upper primary school in Nsukka central local government area. *Unpublished Med project department of science education, University of Nigeria, Nsukka.*

Oba, F. J., & Aladejana A. L. (2014). Effects of gender on students' attitude to physics in secondary schools in Oyo State, Nigeria. *European Scientific Journal, 7*, 1857 – 7881.

Obanya, P. (2012). Curriculum overload in the language education programme for basic education. In A. Lawal I. Isiugo-Abanihe & I.N. Ohia (eds) perspective in applied linguistic in language and literature (pp 202-215) Ibadan: Sterling Horden publishers.

Obioma, G. O. (2012). Popularizing mathematical science for technological development. reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Obodo, G. C. (2012). Principles and practices of mathematics education in Nigeria. Enugu: Flowstone Press.

Obodo, G. C. (2015). Developing positive attitudes and interest of mathematics students in nigeria secondary schools. reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Oche, E. S, (2012) Assessing the relative effectiveness of three teaching methods in the measurement of student‟ achievement in mathematics. *Journal of Emerging Trends in Educational Research and Policy Studies* (JETERAPS) 3(4): 479-486.

Odeyemi, J. O. (2015). Critical thinking: an essence of learning mathematics. *reflective and intellective position papers on mathematics education issues. Published 2015 By*

Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Odili, G. A. (2015). A critique of Nigerian mathematics teachers preparation programmes for the secondary school levels: reflective and intellective position papers on mathematics education issues. Published 2015 By Marvelous Mike Ventures Ltd. No.7 Abeokuta Streat, Off Ogbomoso Streat, Area 8 Garki Abuja.

Oganwu, P. I. (2011). Effects of Instructional Strategy on Student's Concepts attainment in Social Studies; *Nigerian Journal of Curriculum Studies. Nigerian Educational Research and Development Council Sheda Abuja, 12(1);* 197

Ohuche, R.O. (2010). *Explore mathematics with year children*. Onitsha Summer educational Publisher Onitsha.

Okorie, K.E. (2012). The extent of use of visual aids in the teaching of mathematics in Okigwe and Owerri educational Zone. Unpublished Undergraduate project, U.N.N.

Olaniyan, M. O. & Salman, M.F. (2015).Causes of mathematics phobia among senior school students: Empirical evidence from Nigeria. The African Symposium 15(1), 50-56.

Oyeniran J. O. (2011) Perception of junior secondary school mathematics teachers on mathematics curriculum implementation as a tool for re-branding Nigeria, Emmanuel Alayande College of Education, Oyo, Oyo State.

Parker, J.D., Cresques, R., Haris, J., Majeski, S.A., Wood, L.M &Hogan, M.J. (2013). *Academic success in high school: Does emotion matter?* ERIC.

Penner, E. & Richard L. (2011). Externally modeling mental model. http www Springerlink.Com/index/r040n/12386506146.pdf.htlm.

Richard, C. (2016). *Mathematics learning*. *Complex problem solving and geometry learning*. University Press.

Richardson, F. C., & Suinn, R. M. (2009). The mathematics anxiety rating scale: psychometric data. *Journal of Counseling Psychology, 19*, 551–554.

Ryder, L.H. (2014). An alternative language learning model httpwww.Math.rice-edu/dfield.com.htlm.

Sambo, A. A. (2015). *Research Methods in Education* Ibadan Stirling-Horden Publishers (Nig) Ltd, Ibadan, Nigeria.

Shikuku B. N. (2009). *Effect of syllabus coverage on student performance at KCSE mathematics:*
a case of Kakamega south district, Kenya. Lap Lambert Academic Publishing: reha gmbh, DudweilesrstraBe 72 66111 Saarbrucken. www.rehagmbh.de

Slamet, A., Wahyudin, W. & Tatang, H. (2020). The effects of contextual group guided discovery learning on students' mathematical understanding and reasoning. *Jurnal Prima Edukasia*, 8 (2), 106-114.

Suydam M.N. & Higgins J. L. (2012). Concrete models in the study of mathematics and science in Secondary school. Research Paper of Information Conference Center. Ohio State University (ERIC).

Thomas, A. & Lasisi N. (2015). effects of guided discovery and problem solving instructional strategies on achievement of secondary school students in Volumetric Analysis in Minna Metropolis, Niger State. *ATBU Journal of Science, Technology and Education*, 3(4), 75-87

Tillfors, M. (2003). Why do some individuals develop social phobia? A review with emphasis on the neurobiological influences. *Nord Journal of Psychiatry (Taylor & Francis)* 58(4), 67-75.

Tswani, A.R. (2015). Tracing factors that facilitate achievement in mathematics in traditional disadvantaged secondary schools, Unpublished PhD Thesis, University of Pretoria, Pretoria

Udo, M. E. (2010). Effect of guided-discovery, students-center demonstration and expository instructional strategies on students‟ performance in Chemistry. *Africa Research Review. And International Multidisplinary Journal, Ethiopia, 5(4) 389-398.*

Udo, M. E. (2011). Effects of problem-solving, guided-discovery and expository teaching strategies on students' performance in Redox Reactions. *An International Multidisciplinary Journal, Ethiopia,* 5(4), 231-241.

Udoh, I. U. (2014). Management of education environment, effective teaching and learning. An Unpublished M.Ed Thesis Faculty of Education, University of Uyo. Akwa-Ibom State

Udoh, M. U. (2012). Administrative constrain and the effectiveness of principals of secondary commercial schools in Akwa-Ibom State Faculty of Education, University of Uyo. Akwa-Ibom State.

Udokang, S. J. (2012), Resources-based learning and quality education in Nigeria in Ibe-Bassey (ed) *University of Uyo Journal of Education,* 2(1), 39-48.

Ukamaka, U. T. (2014). Effect of guided inquiry methods on students' achievement and interest in basic science. Unpublished Med project department of science education, University of Nigeria, Nsukka.

Umoren S.N. (2012). Mathematics modeling approaching to task present. Among Junior Secondary Mathematics Studies. Unpublished Masters Project. University of Nigeria, Nsukka.

Usman, K.O. (2012). The need to retain in-service Mathematics teachers for the attainment of the objectives of universal Basic Ed. (UBE). *The Journal of the Mathematics Association of Nigeria.* ABACUS 27(1) 37-44.

Walle, P. (2010). Communication and conflict: Social anxiety and learning. In the proceedings of Academy of Organizational Culture: Communications and Conflict, 14(2), 16-19.

Wasike, D.W. (2013). Effect of socialized mathematical language module on students' understanding of mathematics and their perception of the learning environment: a case of form two students of Bungoma district, Kenya. Unpublished PhD thesis, University of Kenya.

Watermeyer, C. (2012). Physical access and the UCT Built Environment. Cape Town: disability unit.

West African Examination Council (2020). Chief Examiners Report from 2008-2017

Xia, X., Lu, C. & Wang, B. (2013). Research on mathematics instruction experiment based problem posing, *Journal of Mathematics Education*, *1*(1), 153-163.

Yaako, S. M. & Okoro, M. (2019). Problem solving strategy on senior secondary school students' performance and attitude toward mathematics in Khana Local Government Area Rivers State. *International Journal of Education and Evaluation*, 5(3), 68-77.

Yapwi, B. (2015). Curriculum implementation; inclusion of children with special needs in the UBE Progrannes: *Nigerian Journal of Curriculum Studies. Nigerian Educational Research and Development Council Sheda Abuja, 12(1).* 151-162

Yara, P.O. & Otieno, K.O. (2010). Teaching/learning resources and academic performance in mathematics in secondary schools in Bondo district of Kenya, *Asian Social Science*, *6* (12) 126-132.

APPENDICES

Appendix A

Mathematics Achievement Test (MAT)

1. For what value of x is the fraction $\frac{x^2-3x+2}{4x+3}$ undefined a) $\frac{13}{6}$ b) $\frac{4}{5}$ c) $\frac{7}{6}$ d) $-\frac{3}{4}$ e) $\frac{13}{12}$

2. The sum of two numbers is 105 their product is 2736, find the numbers
(a) 24 and 21 (b) 48 and 57 (c) 77 and26 (d) 77 and 32 (e) 23 and 45

3. A man 37years old and his child's age is 8 years, how many years ago was the product of their age 96 years? (a) 5 years (b) 4 years (c) 3 years (d) 2years (e) 22 years

4. Find a number which, when added to its square make 90. (a) 4 (b) 9 (c) 6 (d) 8 (e) 3

5. what is the number such that as that when 5/6 of it is subtracted from $3\frac{1}{2}$ the result is the same as when 2/3 of it is added to it. A) $\frac{17}{9}$ B), $\frac{3}{5}$ C) $\frac{3}{11}$ D) $\frac{1}{6}$ E) 7

6. Consider this example, the average cost of a number of pencils is 50k, if all the pencils cost #20.00, find the total number of pencils. A 40 B 65 C 34 D 29 E 78

7. Find the product of $\frac{1}{4}$ and the sum of $\frac{3}{4}$ and $\frac{1}{2}$ a) $\frac{13}{6}$ b) $\frac{3}{7}$ c) $\frac{5}{16}$ d) $\frac{3}{4}$ e) $\frac{3}{11}$

8. Find the positive difference between the sum of 1.6 and 2 and the product of 7 and 0.4
A, 3.4 B. 2.5 C. 6.6 D. 0.8 E 2.6

9. Solve the equation 4(3-5n) - 7(5-4n) + 3 = 0

(a) 5/2 (b) 3/5 (c) 3/7 (d) ¾ (e) -3

10. Change the expression into word 20 – (3 + 9)

(a) Subtract the sum of 3 and 9 from 20 (b) Add the product of 3 and 9 to 20

(c) Subtract 20 from the sum of 3 and 9 (d) Add the sum of 3 and 9 to 20

(e) Find the sum of 20, 3 and 9.

11. When 48 is divided by the sum of 2 and n. if the result is 3. What is n?

a) 13. (b) 14. (c) 24 (d) 12 (e) 15

12. Labaran has x kobo, kunle has 15 less than Laraba. Together the number of kobo they have is: (a) x-15 (b) 2x (c) 2x – 15 (d) 2x +15 (e) 15

13. In a class containing 32 students, a student can do either Government or History or both. If 16 students do Government 18 do History and 3 do none of the subject, find how many do both. A, 6 B, 9 C, 4 D,8 E 5

14. When 48 are divided by the sum of 5 and a certain number is 3. What is the number?
(a) 11 (b) 14 (c) 26 (d) 15 (e) 30

15. I thought of a number and subtract 5 from it, I then divide 72 by the result. If my answer is 4, what number did I think of?

(a) 23 (b) 32 (c) 42 (d) 20 (e) 22

16. The sum of four consecutive number is 58, Find the numbers?

(a) 13, 14, 17, 18 b.) 26, 27, 28, 29 c.) 6, 7, 8, 9 d.) 13, 14, 15, 16 e) 3, 4, 5, 6

17. Ojo bought 12 oranges from the market. His Daddy plucked 14 more Oranges for him from the garden, how many Oranges does Ojo now have?

A, 34 Oranges B. 45 Oranges C. 62 Oranges D. 78 Oranges E 26 Oranges.

18. Given the difference between 8 and another number is 17. Find the possible value, for the number. A, 34 B. 25 C. 62 D. 78 E 26 .

19. A brother is 3 years older than his sister, 5 years ago; the ratio of their ages was 4:3. Their present ages are? (a) 17 years and 14 years (b) 14 years and 12 years (c) 17 years and 8 years (d) 8years and 17 years (e)17 year and 7 years

20. find one ninth of the difference between 256 and 13 (a) 72 (b) 27 (c) 40 (d) 70 (e) 23

21. If 14 men can cultivate 42 acres of land in 18 weeks, how many weeks will it take 21 men working at the same rate to cultivate 56 acres of land?

(a)16weeks (b) 70weeks (c) 63weeks (d) 73 weeks (e) 80weeks

22. What is the largest of three consecutive even integers if their sum is 72.

(a) 26 (b) 7 (c) 70 (d) 36 (e) 72

23. One third of a number added to four-fifths of itself is equal to 17 find the number.

A, 34 B. 25 C. 62 D. 78 E 15

24. Solve the equation 1/5 – x = 1/x – 3: (a) 1 (b) -2 (c) 0 (d) 4 (e) 2

25. Find the product of the 11 and the positive difference between 4 and 10 A, 34 B. 25 C. 66 D. 78 E 26

26. Find the sum of .9 and the product of 1.7 and 3 A,4 B. 25 C. 62 D.78 E 6

27. In the family of eight, one-eight of the members are very tall, and one-quarter of them are very short. The rest are of average in height. How many are of average heights in that family? A, 4. 2 B, 3.9 C, 4.3 D,1.8 E 1.5

28. Solve for n when the product 5 and sum of square of n and 3, is equals to 420.

A) 4 B. 9 C. 6 D.7 E 6

29. The fraction $\frac{1}{6} of\ X$, is added to $\frac{1}{4} of\ X$, the result is $\frac{6}{24}$.

A) $\frac{3}{5}$ B. $\frac{1}{6}$ C. $\frac{6}{7}$ D. $\frac{4}{13}$ E $\frac{11}{6}$

30. write in word 4(3-5n)

a) four multiply by the difference of three and five multiply by n
b) product of four and difference of three from five multiply by n
c) three subtract from five multiply by n, then multiply by four.
d) five multiply by n added to three, multiply by four
e) four multiply by subtraction of five and three.

MARKING SCHEME

1. D
2. B
3. A
4. B
5. C
6. A
7. C
8. D
9. A
10. A
11. B
12. C
13. E
14. A
15. A
16. D
17. E
18. E
19. A
20. B
21. D
22. A
23. E
24. D
25. C
26. E
27. A
28. B
29. A
30. A

Appendix B

KUDER-RICHARD FORMULA 21 RELAIBILITY COEEFICIENT FOR MAT.

$$K - R21 = \frac{n}{n-1}\left[1 - \frac{m(n-m)}{ns^2}\right]$$

where;

n= Number of Items in the test

m= Mean of the test Score

s^2 = Variance of the set test scores

and also n = 30; m = 21.41; s^2= 48.96

$$K - R21 = \frac{30}{30-1}\left[1 - \frac{31.41(30-21.41)}{30(48.66)}\right]$$

$$= \frac{30}{29}\left[\frac{1-25.87(14.13)}{1958.4}\right]$$

$$= 1.034482759\left[1 - \frac{21.41(8.59)}{1459.8}\right]$$

$$= 1.034482759\left[1 - \frac{183.9119}{1459.8}\right]$$

$$= 1.034482759[1 - 0.125984313]$$

$$= 1.034482759[0.874015687]$$

$$= 0.904154$$

$$= 0.904$$

APPENDIX C

QUESTIONNAIRE ON ATTITUDE OF STUDENTS ON EXPERIMENTAL METHOD OF TEACHING

Dear Respondent,

This questionnaire is designed to elicit your responses on above subject matter. The questionnaire focus on guided discovery and graphical approaches on mathematics achievement and attitude of senior secondary school students in Minna, Metropolis. Your response shall be respected and treated with utmost confidentiality. Below are items that you are kindly requested to read through and respond to accordingly.

SECTION A: BIO-DATA INFORMATION

Name of School……………………………………………………

Tick ( )

Gender: Male ( ) Female ( )

Section B: Attitude of senior secondary school students to mathematics is after taught with the guided discovery method?

Note: SA – Strongly Agree, A – Agree, D – Disagree, SD – Strongly Disagree, U- Undecided

S/N	**Item**	**SA**	A	**U**	**SD**	**D**
1	I like mathematics as a subject					
2	I offer mathematics because it is compulsory subject					
3	Mathematics concepts are interesting to me					
4	The mathematics lessons are always interesting					
5	Mathematics is useful to all science students					
6	The syllabus for mathematics is too complex					
7	The study of mathematics enable us appreciate other aspects of science and technology					
8	Mathematics is a very useful subject					
9	I find mathematics subject easy to understand with guided discovery method					
10	I would like to be trained as a mathematics teacher					
11	I would like to be a scientist with specialization in mathematics					
12	I don’t get tired during mathematics lesson if taught with instructional materials					

13	I don't dose off any time we study mathematics in the classroom					
14	I find it easy to understand complex and abstract concepts in mathematics					
15	Guided discovery method instructional packages makes it easy for the teacher to repeat, re-explain and summarized contents					
16	Lessons arewell prepared and organized when they are on guided discovery method instructional packages					
17	Guided discovery method instructional packages makes learning more interesting and exciting					
18	Guided discovery instructional packages makes the teachers time to be well managed					
19	I like guided discovery instructional packages instruction because they are well planned and structured					
20	It is easier to understand contents when my teacher uses guided discovery instructional packages as a medium of delivery					
21	Students behave well in next lesson after listening to guided discovery instructional packages of the previous contents					
22	I like guided discovery instructional packages because it gives opportunity to listen to contents over and over					
23	I learn more when guided discovery instructional packages instructions are used to augument classroom lesson					
24	I would perform better if guided discovery instructional packages instructions could be used to augument classroom lessons more					
25	I prefer lessons augmented with guided discovery instructional packages instruction					
26	I will encourage the use of guided discovery instructional packages instructions for easy understanding, comprehension and retention of contents					
27	Guided discovery instructional package instructional package instruction are not too fast					
28	I concentrate better in the class but I still enjoy guided discovery instructional packages augmented instructions					
29	I have more confidence by listening to guided discovery instructional packages augmented instruction after lessons					
30	Students concentrate during the teaching process while using guided discovery					

Section C: attitude of senior secondary school student to mathematics is after taught with the graphical approach?

Note: SA – Strongly Agree, A – Agree, D – Disagree, SD – Strongly Disagree, U- Undecided

S/N	Item	SA	A	U	SD	D
1	I like mathematics as a subject					
2	I offer mathematics because it is compulsory subject					
3	Mathematics concepts are interesting to me					
4	The mathematics lessons are always interesting					
5	Mathematics is useful to all science students					
6	The syllabus for mathematics is too complex					
7	The study of mathematics enable us appreciate other aspects of science and technology					
8	Mathematics is a very useful subject					
9	I find mathematics subject easy to understand with graphical approach					
10	I would like to be trained as a mathematics teacher					
11	I would like to be a scientist with specialization in mathematics					
12	I don't get tired during mathematics lesson if taught with instructional materials					
13	I don't dose off any time we study mathematics in the classroom					
14	I find it easy to understand complex and abstract concepts in mathematics					
15	Graphical approach instructional packages makes it easy for the teacher to repeat, re-explain and summarized contrents					
16	Lessons arewell prepared and organized when they are on graphical approach instrucytional packages					
17	Graphical approach instructional packages makes learning more interesting and exciting					
18	Graphical approach instructional packages makes the teachers time to be well managed					
19	I like graphical approach instructional packages instruction because they are well planned and structured					
20	It is easier to understand contents when my teacher uses graphical approach instructional packages as a medium of delivery					
21	Students behave well in next lesson after listening to graphical approach instructional packages of the previous contents					

22	I like graphical approach instructional packages because it gives opportunity to listen to contents over and over					
23	I learn more when graphical approach instructional packages instructions are used to augument classroom lesson					
24	I would perform better if graphical approach instructional packages instructions could be used to augument classroom lessons more					
25	I prefer lessons augumented with graphical approach instructional packages instruction					
26	25. I will encourage the use of graphical approach instructional packages instructions for easy understanding, comprehension and retention of contents					
27	Graphical approach instructional package instructional package instruction are not too fast					
28	I concentrate better in the class but I still enjoy graphical approach instructional packages augumented instructions					
29	I have more confidence by listening to graphical approach instructional packages augumented instruction after lessons					
30	Students concentrate during the teaching process while using graphical approach					
	Grand Mean					

Appendix D

Reliability Coefficient for MARS

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.883	.871	20

Reliability coefficient is 0.88

APPENDIX E

FIELD PICTURES


ONE IN TOWN


ONE IN TOWN

APPENDIX F
INTRODUCTORY LETTER

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT SCIENCE EDUCATION

Vice Chancellor: PROF. ABDULLAHI BALA, Ph.D Fssn
Head of Department: DR. RABIU M. BELLO PhD, MSTAN

Federal University of Technology
P.M.B. 65,
Minna, Niger State.
Nigeria.

Date: 20/05/2021

Name of Student: MAGA david Sule

Matriculation No: 2017/SSTE/7226

Status: ______________

TO WHOM IT MAY CONCERN

The bearer, is a postgraduate student of the department. his/her humbly request for your assistance/support with information/data necessary for research towards improvement in knowledge skills and attitudes in line with international best practices for quality research output in the University.

The data/information given shall be used only for the purpose of the research and absolute confidentiality shall be maintained.

Please accept the assurances of my esteem regards.

Thank you.

Head of Dept. Science Education
05 MAY 2021
Fed. University of Tech. Minna

Dr. Rabiu M. Bello
HOD, Science Education.

Contacts: +234-803-592-7009
+234-802-635-6884
E-mail: drrabiu@futminna.edu.ng.

Original collected by H.O.D Science A.B.S.S. minna.

H.O.D Science
09/06/2021
091

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT SCIENCE EDUCATION

Vice Chancellor: PROF. ABDULLAHI BALA, Ph.D Fssn
Head of Department: DR. RABIU M. BELLO PhD, MSTAN

Federal University of Technology
P.M.B. 65,
Minna, Niger State.
Nigeria.

Date: 20/05/2021

Name of Student: Ndaba david sule

Matriculation No: 2017/SSTE/7226

Status: ______________________

TO WHOM IT MAY CONCERN

The bearer is a postgraduate student of the department. his/her humbly request for your assistance/support with information/data necessary for research towards improvement in knowledge skills and attitudes in line with international best practices for quality research output in the University.

The data/information given shall be used only for the purpose of the research and absolute confidentiality shall be maintained.

Please accept the assurances of my esteem regards.

Thank you.

Head of Dept. Science Education
05 MAY 2021
Fed. University of Tech. Minna

Dr. Rabiu M. Bello
HOD, Science Education.

Contacts: +234-803-592-7009
+234-802-635-6884
E-mail: drrabiu@futminna.edu.ng.

Originated Collected by H.O.D Science
Bosso secondary school Minna.
H.O.D sciences
09

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT SCIENCE EDUCATION

e Chancellor: PROF. ABDULLAHI BALA, Ph.D Fssn
ad of Department: DR. RABIU M. BELLO PhD, MSTAN

Federal University of Technology
P.M.B. 65,
Minna, Niger State.
Nigeria.

Date: 20/05/2021

Name of Student: Ndaga david sule

Matriculation No: 2017/SSTE/7226

Status: ______________________

TO WHOM IT MAY CONCERN

The bearer is a postgraduate student of the department. his/her humbly request for your assistance/support with information/data necessary for research towards improvement in knowledge skills and attitudes in line with international best practices for quality research output in the University.

The data/information given shall be used only for the purpose of the research and absolute confidentiality shall be maintained.

Please accept the assurances of my esteem regards.

Thank you.

Head of Dept. Science Education
05 MAY 2021
Fed. University of Tech. Minna

Dr. Rabiu M. Bello
HOD, Science Education.

Contacts: +234-803-592-7009
+234-802-635-6884
E-mail: drrabiu@futminna.edu.ng.

Original collected by H.O.D Science
Gov't. Day Sec. Sch. Minna.

H.O.D Science

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

School of Science and Technology Education

DEPARTMENT OF SCIENCE EDUCATION

Vice Chancellor: PROF. ABDULLAHI BALA, PhD, Fssn
H.O.D.: DR. Rabiu M. Bello PhD, MSTAN,fdbi

Federal University of Technology,
P.M.B. 65,
Minna, Niger State.
Nigeria.

*Your Ref:*________________

*Our Ref:*________________

Date: 09/03/2020

Name: NDABA DAVID SULE

Matriculation No: M/TECH/SSTE/2017/7226

TO WHOM IT MAY CONCERN

The student/ Candidate whose particulars appear on the form is carrying out his/her final year project work.

Please, kindly assist him/her in whatever way possible towards completing this research work.

Thank you in anticipation of your full cooperation.

09/03/2020

Head of Dept. Science Education
18 MAR 2021
Fed. University of Tech. Minna

Dr. Rabiu M. Bello
HOD, Science Education.

Contacts: +234-803-592-7009
+234-802-635-6884
E-mail: drrabiu@futminna.edu.ngssssss

APPENDIX G
LIST OF SECONDARY SCHOOLS

DEPARTMENT OF PLANNING, RESEARCH AND STATISTICS
NIGER STATE MINISTRY OF EDUCATION, MINNA
ENROLMENT OF SSII STUDENTS BY SCHOOL, LGA AND GENDER

S/N	SCHOOL NAME	TOWN	LGA	TYPE OF SCHOOL(PUBLIC OR PRIVATE)	SECTOR / LEVEL	LOCATION (URBAN OR RURAL)	ENROLMENT SS2		
							MALE	FEMALE	TOTAL
1	DENDO SECONDARY SCHOOL, AGAIE	Agaie	AGAIE	Public	JSS and SSS	Rural	201	0	201
2	MAL. MUHAMMADU BABA DAY SECODARY SCHOOL	Agaie	AGAIE	Public	JSS and SSS	Urban	322	153	475
3	MUHAMMADU BELLO DAY SECONDARY SCHOOL	Tagagi	AGAIE	Public	JSS and SSS	Rural	44	16	60
4	GOVERNMENT GIRLS SECONDARY SCHOOL, AGAIE	Agaie	AGAIE	Public	JSS and SSS	Urban	0	159	159
5	GOVERNMENT DAY SECONDARY SCHOOL, ZAGO	Zago	AGAIE	Public	JSS and SSS	Rural	103	48	151
6	MUHAMMED KUDU DAY SECONDARY SCHOOL, NAMI	Nami	AGAIE	Public	JSS and SSS	Rural	32	6	38
7	DAY SECONDARY SCHOOL, KUTIRIKO	Kutiriko	AGAIE	Public	JSS and SSS	Rural	75	35	110
8	GOVERNMENT DAY SCIENCE COLLEGE, ETSU-GAIE	Etsugaie	AGAIE	Public	JSS and SSS	Rural	61	14	75
9	GOVERNMENT SCIENCE COLLEGE, BARO	Baro	AGAIE	Public	JSS and SSS	Rural	70	23	93
10	GOVERNMENT DAY SECONDARY SCHOOL, ESSANGI	Essangi	AGAIE	Public	JSS and SSS	Rural	52	12	64
11	SHEIKH YUNUSA KENCHI COLLEGE OF ART AND ISLAMIC STUDIES AGAIE	Agaie	AGAIE	Public	JSS and SSS	Rural	164	80	244
12	GOVERNMENT DAY SECONDARY SCHOOL MAGO	Mago	AGWARA	Public	JSS and SSS	Rural	24	6	30
13	GOVERNMENT SECONDARY SCHOOL NEW PAPIRI	New-Papiri	AGWARA	Public	JSS and SSS	Rural	74	48	122
14	GOVERNMENT DAY SECONDARY SCHOOL ROFIA	Rofia	AGWARA	Public	JSS and SSS	Urban	63	8	71
15	GOVERNMENT SECONDARY SCHOOL GALLAH	Gallah	AGWARA	Public	JSS and SSS	Rural	52	38	90
16	GOVERNMENT SCIENCE COLLEGE AGWARA	Agwara	AGWARA	Public	JSS and SSS	Rural	91	50	141
17	WOMEN DAY COLLEGE BIDA	Bida	BIDA	Public	JSS and SSS	Urban	0	49	49
18	JAMA'ATU NASRUL ISLAM COLLEGE OF ARTS AND SCIENCE	Bida	BIDA	Public	JSS and SSS	Urban	85	118	203
19	GOVERNMENT DAY SECONDARY SCHOOL BANMA	Bida	BIDA	Public	JSS and SSS	Urban	0	196	196
20	GOVERNMENT GIRLS SCIENCE COLLEGE BIDA	Bida	BIDA	Public	SSS ONLY	Urban	0	640	640
21	COLLEGE OF ART & ISLAMIC STUDIES, BIDA	Bida	BIDA	Public	JSS and SSS	Urban	120	189	309
22	GOVERNMENT GIRLS DAY SECONDARY SCHOOL	Bida	BIDA	Public	JSS and SSS	Urban	0	805	805
23	DAY SECONDARY SCHOOL EYAGI, BIDA	Bida	BIDA	Public	JSS and SSS	Urban	301	124	425
24	GOVERNMENT SCIENCE COLLEGE (BTC) BIDA	Bida	BIDA	Public	JSS and SSS	Urban	436	315	751
25	GOVERNMENT COLLEGE BIDA	Bida	BIDA	Public	JSS and SSS	Urban	316	0	316
26	NDAYAKO DAY SECONDARY SCHOOL	Bida	BIDA	Public	JSS and SSS	Urban	600	47	647
27	GOVERNMENT MODEL SCIENCE COLLEGE, BIDA	Bida	BIDA	Public	ALL LEVELS	Urban	378	238	616
28	GOVERNMENT TECHNICAL COLLEGE BIDA	Bida	BIDA	Public	SSS ONLY	Urban	636	110	746
29	GOVERNMENT SECONDARY SCHOOL NEW BUSSA	New-Bussa	BORGU	Public	JSS and SSS	Urban	64	43	107
30	WOMEN DAY COLLEGE NEW-BUSSA	New-Bussa	BORGU	Public	JSS and SSS	Urban	0	55	55
31	FEDERAL GOVERNMENT GIRLS COLLEGE NEW BUSSA	New-Bussa	BORGU	Public	JSS and SSS	Rural	0	80	80
32	GOVERNMENT SECONDARY SCHOOL, KIGBERA	Kigbera	BORGU	Public	JSS and SSS	Rural	4	12	16
33	GOVERNMENT DAY SECONDARY SCHOOL KONKOSO	Konkoso	BORGU	Public	JSS and SSS	Rural	35	14	49
34	SENIOR SECONDARY SCHOOL SHAGUNU	Shagunu	BORGU	Public	JSS and SSS	Rural	61	20	81
35	SENIOR COLLEGE OF ARTS AND ISLAMIC STUDIES	Babanna	BORGU	Public	JSS and SSS	Rural	35	10	45
36	GOVERNMENT SECONDARY SCHOOL,BABANNA	Babanna	BORGU	Public	JSS and SSS	Rural	86	30	116
37	GOVERNMENT SECONDARY SCHOOL NASSARAWA GUFFANTI	Guffanti	BORGU	Public	JSS and SSS	Rural	42	8	50
38	GOVERNMENT DAY SECONDARY SCHOOL KARABONDE	Karabonde	BORGU	Public	JSS and SSS	Rural	68	53	121
39	GOVERNMENT DAY SECONDARY SCHOOL, WAWA	Wawa	BORGU	Public	JSS and SSS	Rural	96	88	184
40	GOVERNMENT DAY SECONDARY SCHOOL PISSA	Pissa	BORGU	Public	JSS and SSS	Rural	53	24	77
41	GOVERNMENT DAY SECONDARY SCHOOL KABE	Kabe	BORGU	Public	JSS and SSS	Rural	31	12	43
42	GOVERNMENT DAY SECONDARY SCHOOL DEKARA	Dekara	BORGU	Public	JSS and SSS	Rural	22	9	31
43	GOVERNMENT DAY SECONDARY SCHOOL LUMMA SANKE	LUMMA SANKE	BORGU	Public	JSS and SSS	Rural	22	9	31
44	GOVERNMENT TECHNICAL COLLEGE NEW-BUSSA	Dogon-Gari	BORGU	Public	SSS ONLY	Rural	183	39	222
45	ARMY DAY SECONDARY SCHOOL , WAWA	WAWA NEW BUSSA	BORGU	Public	JSS and SSS	Rural	96	88	184
46	ALHAJI MOHAMMED MUSA KIGERA SCIENCE COLLEGE, NEW-BUSSA	New-Bussa	BORGU	Public	SSS ONLY	Urban	241	107	348
47	FEDERAL GOVERNMENT COLLEGE MINNA	Tungan-Goro	BOSSO	Public	JSS and SSS	Urban	172	140	312
48	ABDULLAHI DADA SECONDARY SCHOOL MAIKUNKELE	Maikunkele	BOSSO	Public	JSS and SSS	Urban	63	59	122
49	DAY SECONDARY SCHOOL MAIKUNKELE 'A'	Maikunkele	BOSSO	Public	JSS and SSS	Urban	68	55	123
50	DAY SECONDARY SCHOOL CHANCHAGA MINNA'B'	Chanchaga	BOSSO	Public	JSS and SSS	Urban	144	161	305
51	GOVERNMENT ARMY DAY SECONDARY SCHOOL	Chanchaga	BOSSO	Public	JSS and SSS	Urban	360	362	722
52	BOSSO SECONDARY SCHOOL MINNA	Shango	BOSSO	Public	JSS and SSS	Urban	211	199	410
53	HILLTOP MODEL SECONDARY SCHOOL	Maitunbi, Minna	BOSSO	Public	ALL LEVELS	Urban	188	292	480
54	NIGER STATE SCHOOL FOR SPECIAL EDUCATION MINNA	Bosso	BOSSO	Public	ALL LEVELS	Urban	25	13	38
55	DAY SECONDARY SCHOOL MAITUMBI MINNA	Maitunbi, Minna	BOSSO	Public	JSS and SSS	Urban	184	200	384
56	SHEIKH MUHAMMAD SANBO COLLEGE OF ARTS AND ISLAMIC STUDIES TUDUN FULANI MIN	Tudun-Fulani, Minna	BOSSO	Public	JSS and SSS	Urban	345	49	394
57	DAY SECONDARY SCHOOL GBADA GIDAN MONGORO	Mongoro	BOSSO	Public	JSS and SSS	Rural	115	94	209
58	GOVERNMENT DAY SECONDARY SCHOOL BEJI	Beji	BOSSO	Public	JSS and SSS	Rural	79	87	166
59	DAY SECONDARY SCHOOL GARATU	Garatu	BOSSO	Public	JSS and SSS	Rural	74	47	121
60	GOVERNMENT SENIOR SECONDARY SCHOOL KAMPALA	Kampala	BOSSO	Public	JSS and SSS	Urban	58	80	138
61	DAY SECONDARY SCHOOL SHATTA	Shatta	BOSSO	Public	JSS and SSS	Rural	50	27	77
62	DAY SECONDARY SCHOOL PYATA	Pyata	BOSSO	Public	JSS and SSS	Rural	59	66	125
63	GOVERNMENT SCIENCE COLLAGE CHANCHAGA	Chanchaga	BOSSO	Public	JSS and SSS	Urban	220	251	471
64	MARYAM BABANGIDA GIRLS SCIENCE COLLEGE, BOSSO	Bosso-Minna	BOSSO	Public	SSS ONLY	Urban	0	372	372

Page 1 of 5

65	MODEL SCIENCE COLLEGE TUDUN FULANI	Tudun-Fulani, Minna	BOSSO	Public	JSS and SSS	Urban	82	96	178
66	GOVERNMENT TECHNICAL COLLEGE, MINNA	Tungan-Goro	BOSSO	Public	SSS ONLY	Urban	458	66	524
67	MODEL SECONDAARY SCHOOL FUT	Bosso-Minna	BOSSO	Public	ALL LEVELS	Urban	34	36	70
68	DAY SECONDARY SCHOOL KWASAU	Kwasau	CHANCHAGA	Public	JSS and SSS	Urban			0
69	DAY SECONDARY SCHOOL BARIKIN SALE	Barikin-Sale, minna	CHANCHAGA	Public	JSS and SSS	Urban	150	178	328
70	DAY SECONDARY SCHOOL LIMAWA	Limawa	CHANCHAGA	Public	JSS and SSS	Urban	347	202	549
71	GOVERNMENT DAY SECONDARY SCHOOL, BOSSO ROAD	Bosso	CHANCHAGA	Public	JSS and SSS	Urban	261	314	575
72	WOMAN DAY COLLEGE	Minna	CHANCHAGA	Public	JSS and SSS	Urban	0	107	107
73	ZARUMAI MODEL SCHOOL, MINNA	Minna	CHANCHAGA	Public	ALL LEVELS	Urban	202	206	408
74	GOVERNMENT GIRLS SECONDARY SCHOOL MINNA	Minna	CHANCHAGA	Public	JSS and SSS	Urban	0	948	948
75	AHMADU BAHAGO SECONDARY SCHOOL MINNA	Minna	CHANCHAGA	Public	JSS and SSS	Urban	426	151	577
76	FR. O'CONNELL SCIENCE COLLEGE, MINNA	Minna	CHANCHAGA	Public	JSS and SSS	Urban	474	0	474
77	GOVERNMENT GIRLS SCIENCE COLLEGE, BOSSO ROAD	Minna	CHANCHAGA	Public	JSS and SSS	Urban	0	303	303
78	GOVERNMENT DAY SCIENCE COLLEGE, TUNGA	Tunga	CHANCHAGA	Public	JSS and SSS	Urban	360	362	722
79	GOVERNMENT VOCATIONAL TRAINING CENTER	Kasuwan-Gwari	CHANCHAGA	Public	JSS and SSS	Urban	103	67	170
80	DAY SECONDARY SCHOOL, FAZHI	Fazhi	EDATI	Public	JSS and SSS	Rural			0
81	GOVERNMENT DAY SECONDARY SCHOOL, ROKOTA	Rokota	EDATI	Public	JSS and SSS	Rural	26	7	33
82	GOVERNMENT DAY SECONDARY SCHOOL, EDATI BAFO	Edati-Bafo	EDATI	Public	JSS and SSS	Rural	101	66	167
83	COLLEGE OF ARTS AND ISLAMIC STUDIES, ENAGI	Enagi	EDATI	Public	JSS and SSS	Rural	45	66	111
84	GOVERNMENT DAY SECONDARY SCHOOL ENAGI	Enagi	EDATI	Public	JSS and SSS	Rural	79	30	109
85	DAY SECONDARY SCHOOL GBANGBAN	Gbangban	EDATI	Public	JSS and SSS	Rural	176	32	208
86	GOVERNMENT SECONDARY SCHOOL GONAGI	Gonagi	EDATI	Public	JSS and SSS	Rural	260	223	483
87	GOVERNMENT DAY SECONDARY SCHOOL ETSU TASHA	Etsu-Tasha	EDATI	Public	JSS and SSS	Rural	100	60	160
88	GOVERNMENT DAY SECONDARY SCHOOL GBODOTI	Gbodoti	EDATI	Public	JSS and SSS	Rural	80	53	133
89	GOVERNMENT SECONDARY SCHOOL DIKKO ENAGI	Dikko-Enagi	EDATI	Public	JSS and SSS	Rural	34	24	58
90	DAY SECONDARY SCHOOL KATAMBA BOLOGI	Katamba-Bologi	EDATI	Public	JSS and SSS	Rural	45	55	100
91	GOVERNMENT DAY SECONDARY SCHOOL SAKPE	Sakpe	EDATI	Public	JSS and SSS	Rural	37	28	65
92	GOVERNMENT DAY SENIOR SECONDARY SCHOOL ESTU AUDU	Etsu-Audu	GBAKO	Public	JSS and SSS	Rural	118	10	128
93	GOVERNMENT GIRLS SECONDARY SCHOOL, LEMU	Lemu	GBAKO	Public	JSS and SSS	Urban	0	98	98
94	COLLEGE OF ARTS AND ISLAMIC STUDIES LEMU	Lemu	GBAKO	Public	JSS and SSS	Urban	45	17	62
95	GOVERNMENT DAY SECONDARY SCHOOL, ESSAN PATISAN	Essan-Patisan	GBAKO	Public	JSS and SSS	Rural	26	15	41
96	GOVERNMENT DAY SECONDARY SCHOOL BATAGI	Batagi	GBAKO	Public	JSS and SSS	Rural	120	24	144
97	GOVERNMENT DAY SECONDARY SCHOOL BATAKO	Batako	GBAKO	Public	JSS and SSS	Rural	108	20	128
98	GOVERNMENT SECONDARY SCHOOL, LEMU	Lemu	GBAKO	Public	JSS and SSS	Urban	205	15	220
99	GOVERNMENT DAY SECONDARY SCHOOL, SOMMAJIKO	Sommajiko	GBAKO	Public	JSS and SSS	Rural	67	40	107
100	DAY SECONDARY SCHOOL, GUSADIN	Gusadin	GBAKO	Public	JSS and SSS	Rural	120	25	145
101	DAY SECONDARY SCHOOL, GBADAFU	Gbadafu	GBAKO	Public	JSS and SSS	Rural	140	100	240
102	DAY SECONDARY SCHOOL, EDOZHIGI	Edozhigi	GBAKO	Public	JSS and SSS	Rural	96	88	184
103	GOVERNMENT GIRLS ARABIC SCHOOL DIKO	Diko	GURARA	Public	JSS and SSS	Rural	0	160	160
104	GOVERNMENT DAY SECONDARY SCHOOL, KABO	Kabo	GURARA	Public	JSS and SSS	Rural	144	90	234
105	GOVERNMENT DAY SECONDARY SCHOOL LEFU	Lefu	GURARA	Public	JSS and SSS	Rural	68	49	117
106	GOVERNMENT DAY SECONDARY SCHOOL DAKU	Daku	GURARA	Public	JSS and SSS	Rural	62	37	99
107	GOVERNMENT DAY SECONDARY SCHOOL SULLU	Sullu	GURARA	Public	JSS and SSS	Rural	10	5	15
108	GOVERNMENT DAY SECONDARY SCHOOL G/BABANGIDA	Gawu-Babangida	GURARA	Public	JSS and SSS	Urban	175	120	295
109	GOVERNMENT DAY SECONDARY SCHOOL KUDNA	Kudna	GURARA	Public	JSS and SSS	Rural	62	37	99
110	GOVERNMENT DAY SECONDARY SCHOOL TUNA	Tuna	GURARA	Public	JSS and SSS	Rural	116	46	162
111	GOVERNMENT DAY SECONDARY SCHOOL IZOM	Izom	GURARA	Public	JSS and SSS	Rural	251	108	359
112	GOVERNMENT DAY SECONDARY SCHOOL LAMBATA	Lambata	GURARA	Public	JSS and SSS	Urban	220	76	296
113	GOVERNMENT DAY SECONDARY SCHOOL DIKO	Diko	GURARA	Public	JSS and SSS	Urban	76	55	131
114	GOVERNMENT DAY SECONDARY SCHOOL TUFA	Tufa	GURARA	Public	JSS and SSS	Urban	45	12	57
115	GOVERNMENT SCIENCE SECONDARY SCHOOL IZOM	Izom	GURARA	Public	SSS ONLY	Urban	393	0	393
116	GOVERNMENT DAY SECONDARY SCHOOL DZWAFU	Dzwafu	KATCHA	Public	JSS and SSS	Rural	781	180	961
117	GOVERNMENT DAY SECONDARY SCHOOL BAKEKO	Bakeko	KATCHA	Public	JSS and SSS	Rural	203	54	257
118	GOVERNMENT DAY SECONDARY SCHOOL CHECHE	Cheche	KATCHA	Public	JSS and SSS	Rural	75	30	105
119	GOVERNMENT DAY SECONDARY SCHOOL YINTI	Yinti	KATCHA	Public	JSS and SSS	Rural	130	50	180
120	GOVERNMENT SECONDARY SCHOOL NWOGI	Nwogi	KATCHA	Public	JSS and SSS	Rural	20	10	30
121	DAY SECONDARY SCHOOL KATAEREGI	Kataeregi	KATCHA	Public	JSS and SSS	Rural	110	58	168
122	ISLAMIC EDUCATION CENTRE KATCHA	Katcha	KATCHA	Public	SSS ONLY	Rural	75	40	115
123	GOVERNMENT DAY SECONDARY SCHOOL KATCHA	Katcha	KATCHA	Public	JSS and SSS	Rural	416	35	451
124	GOVERNMENT DAY SECONDARY SCHOOL KAKAKPANGI	Kakakpangi	KATCHA	Public	JSS and SSS	Rural	144	90	234
125	GOVERNMENT DAY SECONDARY SCHOOL BISANTI	Bisanti	KATCHA	Public	JSS and SSS	Rural	68	49	117
126	GOVERNMENT GIRLS COMMERCIAL COLLEGE KATCHA		KATCHA	Public	JSS and SSS	Rural	0	160	160
127	GOVERNMENT MODEL SCIENCE COLLEGE KONTAGORA	Kontagora	KONTAGORA	Public	ALL LEVELS	Rural	74	110	184
128	DAY SECONDARY SCHOOL, SABON-KASUWA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	208	55	263
129	WOMEN DAY COLLEGE KONTAGORA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	0	70	70
130	GOVERNMENT GIRLS DAY SECONDARY SCHOOL	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	0	286	286
131	MUAZU IBRAHIM COMMERCIAL SECONDARY SCHOOL	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	87	44	131
132	DAY SECONDARY SCHOOL UNGUWAN NASSARAWA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	124	116	240
133	GOVERNMENT DAY SECONDARY SCHOOL KONTAGORA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	170	111	281
134	NAGWAMATSE COLLEGE OF ARTS AND ISLAMIC STUDIES	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	264	125	389

135	GOVERNMENT TECHNICAL COLLEGE, KONTAGORA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	176	8	184
136	GOVERNMENT GIRLS SCIENCE UNITY COLLEGE	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	0	303	303
137	GOVERNMENT SCIENCE COLLEGE, KONTAGORA	Kontagora	KONTAGORA	Public	JSS and SSS	Urban	460	177	637
138	UNIVERSAL BESIC EDUCATION MODEL SCIENCE COLLEGE	Kontagora	KONTAGORA	Public	ALL LEVELS	Urban	121	168	289
139	GOVERNMENT BOYS DAY SECONDARY SCHOOL LAPAI	Lapai	LAPAI	Public	JSS and SSS	Urban	155	139	294
140	GOVERNMENT SENIOR SECONDARY SCHOOL KPADA	Kpada	LAPAI	Public	JSS and SSS	Rural	40	36	76
141	BASHABA SENIOR SECONDARY SCHOOL	Takuti-Shaku	LAPAI	Public	JSS and SSS	Rural	110	59	169
142	ZAINAB KURE DAY SECONDARY SCHOOL	Lapai	LAPAI	Public	JSS and SSS	Rural	70	45	115
143	GOVERNMENT GIRLS DAY SECONDARY SCHOOL LAPAI	Lapai	LAPAI	Public	JSS and SSS	Urban	0	324	324
144	MUHAMMADU KOBO SECONDARY SCHOOL LAPAI	Lapai	LAPAI	Public	JSS and SSS	Urban	362	0	362
145	COLLEGE OF ART & ISLAMIC STUDIES LAPAI	Lapai	LAPAI	Public	JSS and SSS	Urban	85	42	127
146	GOVERNMENT SECONDARY SCHOOL GUPA	Gupa	LAPAI	Public	JSS and SSS	Rural	39	30	69
147	GOVERNMENT SECONDARY SCHOOL GULU	Gulu	LAPAI	Public	JSS and SSS	Rural	120	50	170
148	DAY SECONDARY SCHOOL MUYE	Muye	LAPAI	Public	JSS and SSS	Rural	80	60	140
149	GOVERNMENT DAY SECONDARY SCHOOL YELWA	Yelwa	LAPAI	Public	JSS and SSS	Rural	103	36	139
150	DAY SECONDARY SCHOOL EVUTI	Evuti	LAPAI	Public	JSS and SSS	Rural	91	61	152
151	GOVERNMENT SECONDARY SCHOOL EBBO	Ebbo	LAPAI	Public	JSS and SSS	Rural	158	61	219
152	GOVERNMENT SECONDARY SCHOOL TAKUTI ABUJA	Takuti-Abuja	LAPAI	Public	JSS and SSS	Rural	90	29	119
153	DAY SECONDARY SCHOOL GABI LAPAI	Gabi-Lapai	LAPAI	Public	JSS and SSS	Rural	32	28	60
154	DAY SECONDARY SCHOOL GBACIDAN	Gbacidan	LAPAI	Public	JSS and SSS	Rural	28	35	63
155	DAY SECONDARY SCHOOL DANGANA	Dangana	LAPAI	Public	JSS and SSS	Rural	42	35	77
156	GOVERNMENT SCIENCE COLLEGE, GULU	Gulu	LAPAI	Public	SSS ONLY	Rural	130	100	230
157	MARAFA ARABIC AND ISLAMIC SECONDARY SCHOOL, LAPAI	Lapai	LAPAI	Public	ALL LEVELS	Urban	21	18	39
158	A.A.KURE COLLEGE OF ARTS & ISLAMIC STUDIES, NDALOKE	Ndaloke	LAVUN	Public	JSS and SSS	Rural	77	27	104
159	ARMY DAY SCIENCE COLLEGE ,BIDA	Bida	LAVUN	Public	JSS and SSS	Urban	150	103	253
160	COLLEGE OF ARTS & ISLAMIC SCHOOL SANTALI	Santali	LAVUN	Public	JSS and SSS	Rural	38	4	42
161	COMMUNITY TECHNICAL & COMMERCIAL COLLEGE, VUNCHI	Vunchi	LAVUN	Public	JSS and SSS	Rural	77	77	154
162	DAY SECONDARY SCHOOL BATATI	Batati	LAVUN	Public	JSS and SSS	Rural	120	50	170
163	DAY SECONDARY SCHOOL BUSU	Busu	LAVUN	Public	JSS and SSS	Rural	99	86	185
164	DAY SECONDARY SCHOOL DABBAN	Dabban	LAVUN	Public	JSS and SSS	Rural	180	200	380
165	DAY SECONDARY SCHOOL GABA	Gaba	LAVUN	Public	JSS and SSS	Rural	168	26	194
166	DAY SECONDARY SCHOOL JIPAN	Jipan	LAVUN	Public	JSS and SSS	Rural	68	22	90
167	DAY SECONDARY SCHOOL KUTIGI	Kutigi	LAVUN	Public	JSS and SSS	Urban	301	70	371
168	DAY SECONDARY SCHOOL PANTI	Panti	LAVUN	Public	JSS and SSS	Rural	63	32	95
169	GOVERNMENT DAY SECONDARY SCHOOL LANLE	Lanle	LAVUN	Public	JSS and SSS	Rural	23	53	76
170	GOVERNMENT DAYSECONDARY SCHOOL MANBE	Manbe	LAVUN	Public	JSS and SSS	Rural	17	6	23
171	GOVERNMENT SCIENCE COLLEGE DOKO	Doko	LAVUN	Public	JSS and SSS	Rural			0
172	GOVERNMENT. SENIOR SECONDARY SCHOOL JIMA	Jima	LAVUN	Public	JSS and SSS	Rural	200	55	255
173	JUSTICE IDRIS LEGBO SCIENCE COLLEGE KUTIGI	Kutigi	LAVUN	Public	SSS ONLY	Urban	174	0	174
174	SHABA MAHMUD COLLEGE OF ARTS & ISLAMIC STUDIES	Shabafu	LAVUN	Public	JSS and SSS	Rural	98	47	145
175	WOMEN DAY COLLEGE, KUTIGI	Kutigi	LAVUN	Public	JSS and SSS	Urban	0	129	129
176	BAKALA DAY SECON DARY SCHOOL SHAGWA	Shagwa	MAGAMA	Public	JSS and SSS	Rural	147	5	152
177	COMPREHENSIVE SECONDARY SCHOOL IBETO	Ibeto	MAGAMA	Public	JSS and SSS	Rural	217	219	436
178	DAY SECONDARY SCHOOL AUNA	Auna	MAGAMA	Public	JSS and SSS	Rural	126	70	196
179	DAY SECONDARY SCHOOL KAWON AUNA	Auna	MAGAMA	Public	JSS and SSS	Rural	48	18	66
180	DAY SECONDARY SCHOOL SALKA	Salka	MAGAMA	Public	JSS and SSS	Rural	327	228	555
181	GOVERNMENT DAY SECONDARY SCHOOL KURA	Kura	MAGAMA	Public	JSS and SSS	Rural	52	20	72
182	GOVERNMENT DAY SECONDARY SCHOOL NASSARAWA KAINJI	Nassaraw-Kainji	MAGAMA	Public	JSS and SSS	Rural	119	39	158
183	GOVERNMENT SECONDARY SCHOOL, NASKO	Nasko	MAGAMA	Public	JSS and SSS	Rural	256	15	271
184	SAIDU NAMSKA COLLAGE OF ARTS & ISLAMIC STIDIES SALKA	Salka	MAGAMA	Public	JSS and SSS	Urban	72	69	141
185	DAY SECONDARY SCHOOL BOBI	Bobi	MARIGA	Public	JSS and SSS	Rural	60	13	73
186	DAY SECONDARY SCHOOL GULBIN BOKA	Gulbin-Boka	MARIGA	Public	JSS and SSS	Rural	26	10	36
187	DAY SECONDARY SCHOOL KAMFANIN BOBI	Bobi	MARIGA	Public	JSS and SSS	Rural	49	23	72
188	DAY SECONDARY SCHOOL MARIGA	Mariga	MARIGA	Public	JSS and SSS	Rural	55	19	74
189	GOVERNMENT DAY SECONDARY SCHOOL BANGI	Bangi	MARIGA	Public	JSS and SSS	Urban	75	27	102
190	GOVERNMENT DAY SECONDARY SCHOOL BERI	Beri	MARIGA	Public	JSS and SSS	Rural	42	3	45
191	GOVERNMENT SCIENCE COLLEGE KOTONKORO	Kotonkoro	MARIGA	Public	JSS and SSS	Rural	61	30	91
192	DAY SECONDARY SCH KABOJI	Kaboji	MASHEGU	Public	JSS and SSS	Rural	29	14	43
193	EMIRATE SECONDARY SCHOOL MASHEGU	Mashegu	MASHEGU	Public	JSS and SSS	Rural	52	10	62
194	GOVERNMENT DAY SECONDARY SCHOOL IBBI	Ibbi	MASHEGU	Public	JSS and SSS	Rural	50	34	84
195	GOVERNMENT DAY SECONDARY SCHOOL SAHO RAMI	Saho-Rami	MASHEGU	Public	JSS and SSS	Rural	107	23	130
196	COLLEGE OF ARTS AND ISLAMIC STUDIES, MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	53	41	94
197	DAY SECONDARY SCHOOL ,RABBA	Rabba	MOKWA	Public	JSS and SSS	Rural	34	9	43
198	DAY SECONDARY SCHOOL,JA'AGI	Ja'agi	MOKWA	Public	JSS and SSS	Rural	53	20	73
199	DAY SECONDARY SCHOOL,MUWO	Muwo	MOKWA	Public	JSS and SSS	Rural	34	9	43
200	GOVERMENT SCIENCE COLLEGE, MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	177	70	247
201	GOVERNMENT DAY SECONDARY SCHOOL, KPEGE MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	310	114	424
202	GOVERNMENT DAY SECONDARY SCHOOL,TAKUMA	Takuma	MOKWA	Public	JSS and SSS	Rural	57	38	95
203	GOVERNMENT GIRLS DAY SECONDARY SCHOOL,MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	0	150	150
204	GOVERNMENT SCIENCE & VOCATIONAL COLLEGE JEBBA-NORTH	Jebba-North	MOKWA	Public	JSS and SSS	Rural	68	37	105

205	GOVERNMENT SECONDARY SCHOOL,BOKANI	Bokani	MOKWA	Public	JSS and SSS	Rural	176	223	399
206	GOVERNMENT SECONDARY SCHOOL,GBARA	Gbara	MOKWA	Public	JSS and SSS	Rural	324	67	391
207	GOVERNMENT SECONDARY SCHOOL,KPAKI	Kpaki	MOKWA	Public	JSS and SSS	Rural	105	33	138
208	GOVERNMENT SECONDARY SCHOOL,KUDU	Kudu	MOKWA	Public	JSS and SSS	Rural	138	81	219
209	GOVERNMENT SECONDARY SCHOOL,WUYA KEDE	Wuya-Kede	MOKWA	Public	JSS and SSS	Rural	132	30	162
210	HAKIMI ALIYU DAY SECONDARY SCHOOL, MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	368	190	558
211	MUNGO PARK SENIOR SECONDARY SCHOOL,JEBBA	Jebba	MOKWA	Public	JSS and SSS	Rural	93	38	131
212	WOMEN DAY COLLEGE, MOKWA	Mokwa	MOKWA	Public	JSS and SSS	Urban	0	33	33
213	DAY SECONDARY SCHOOL DANDAUDU	Dandaudu	MUNYA	Public	JSS and SSS	Rural	85	70	155
214	DAY SECONDARY SCHOOL FUKA	Fuka	MUNYA	Public	JSS and SSS	Rural	17	3	20
215	DAY SECONDARYSCHOOL, GUNI	Guni	MUNYA	Public	JSS and SSS	Rural	53	22	75
216	DR. MUA'ZU BABANGIDA ALIYU SECONDARY SCHOOL	Sarkin-Pawa	MUNYA	Public	JSS and SSS	Urban	205	156	361
217	GOVERNMENT SECONDARY SCHOOL DAZA	Daza	MUNYA	Public	JSS and SSS	Rural	192	39	231
218	NIGER STATE TEACHER PROFESSIONAL DEVELOPMENT CENTRE	Mararaban-Dandaud	MUNYA	Public	JSS and SSS	Rural	368	190	558
219	ABUBAKAR DADA SENIOR SECONDARY SCHOOL	Paiko	PAIKORO	Public	JSS and SSS	Rural	150	24	174
220	DAY SECONDARY SCHOOL ADUNU	Adunu	PAIKORO	Public	JSS and SSS	Rural	86	45	131
221	DAY SECONDARY SCHOOL BAIDNA	Baidna	PAIKORO	Public	JSS and SSS	Rural	45	21	66
222	DAY SECONDARY SCHOOL GWAM	Gwam	PAIKORO	Public	JSS and SSS	Rural	122	52	174
223	DAY SECONDARY SCHOOL ISHAU	Ishau	PAIKORO	Public	JSS and SSS	Rural	102	81	183
224	DAY SECONDARY SCHOOL KAFFIN KORO	Kaffin-Koro	PAIKORO	Public	JSS and SSS	Rural	131	8	139
225	DAY SECONDARY SCHOOL KWAKUTI	Kwakuti	PAIKORO	Public	JSS and SSS	Rural	79	42	121
226	DAY SECONDARY SCHOOL MARABAN TUDU-UKU	Mararaban Tudu-Uk	PAIKORO	Public	JSS and SSS	Rural	81	135	216
227	DAY SECONDARY SCHOOL NIKUCHI	Nikuchi	PAIKORO	Public	JSS and SSS	Rural	120	83	203
228	DAY SECONDARY SCHOOL TUNGAN-MALLAM	Tungan-Mallam	PAIKORO	Public	JSS and SSS	Rural	77	34	111
229	DAY SECONDARY SCHOOL, FARIN DOKI	Fari-Doki	PAIKORO	Public	JSS and SSS	Rural	49	16	65
230	GOVERNMENT DAY SECONDARY SCHOOL CHIMBI	Chimbi	PAIKORO	Public	JSS and SSS	Rural	83	175	258
231	GOVERNMENT DAY SECONDARY SCHOOL TATIKO	Tatiko	PAIKORO	Public	JSS and SSS	Rural	104	56	160
232	GOVERNMENT DAY SECONDARY SCHOOL TUNGAN AMALE	Tungan-Amale	PAIKORO	Public	JSS and SSS	Rural	25	37	62
233	GOVERNMENT DAY SENIOR SECONDARY, JABO JERE	Jabo-Jere	PAIKORO	Public	JSS and SSS	Rural	30	15	45
234	GOVERNMENT GIRLS SECONDARY SCHOOL KAFFIN KORO	Kaffin-Koro	PAIKORO	Public	JSS and SSS	Rural	0	204	204
235	MARTIN SANDA GIRLS SCIENCE COLLEGE, PAIKO	Sungan-Paiko	PAIKORO	Public	JSS and SSS	Rural	0	119	119
236	SENIOR SECONDARY SCHOOL GABADNA	Gabadna	PAIKORO	Public	JSS and SSS	Rural	33	36	69
237	WOMEN DAY COLLEGE PAIKO	Paiko	PAIKORO	Public	JSS and SSS	Urban	0	120	120
238	AHMADU ATTAHIRU SECONDARY SCHOOL KAGARA	Kagara	RAFI	Public	JSS and SSS	Urban	195	114	309
239	DAY SECONDARY SCHOOL TUNGAN BAKO	Tungan-Bako	RAFI	Public	JSS and SSS	Rural	16	3	19
240	DAY SECONDARY SCHOOL, MAIKUJERI	Maikujeri	RAFI	Public	JSS and SSS	Rural	78	42	120
241	GOVERNMENT DAY SECONDARY SCHOOL PANDOGARI	Pandogari	RAFI	Public	JSS and SSS	Urban	261	165	426
242	GOVERNMENT DAY SECONDARY SCHOOL YAKILA	Yakila	RAFI	Public	JSS and SSS	Rural	65	8	73
243	GOVERNMENT GIRLS ARABIC SECONDARY SCHOOL TEGINA	Tegina	RAFI	Public	JSS and SSS	Rural	0	33	33
244	GOVERNMENT SCIENCE COLLEGE, KAGARA	Kagara	RAFI	Public	SSS ONLY	Urban	263	0	263
245	GOVERNMENT SECODARY SCHOOL TEGINA	Tegina	RAFI	Public	JSS and SSS	Rural	155	97	252
246	MAMMAN KONTAGORA TECHNICAL COLLEGE, PANDOGARI	Pandogari	RAFI	Public	SSS ONLY	Rural	138	6	144
247	MUHAMMADU INUWA DAY SECONDARY SCHOOL KUSHERKI	Kusherki	RAFI	Public	JSS and SSS	Rural	100	31	131
248	SALIHU TANKO DAY SECONDARY SCHOOL KAGARA	Kagara	RAFI	Public	JSS and SSS	Urban	117	98	215
249	SENIOR SECONDARY SCHOOL KWANA	Kwana	RAFI	Public	JSS and SSS	Rural	51	17	68
250	SENIOR SECONDARY SCHOOL MADAKA	Madaka	RAFI	Public	JSS and SSS	Rural	159	67	226
251	WOMEN DAY COLLEGE KAGARA	Kagara	RAFI	Public	JSS and SSS	Urban	0	45	45
252	COLLEGE OF ARTS AND ISLAMIC STUDIES TUNGA MAGAJIYA	Tungan-Magajiya	RIJAU	Public	JSS and SSS	Rural	137	122	259
253	DAY SECONDARY SCHOOL DANRANGI	Danrangi	RIJAU	Public	JSS and SSS	Rural	74	20	94
254	GOVERNMENT GIRLS DAY SECONDARY SCHOOL RAFIN MOTA RIJAU	Rijau	RIJAU	Public	JSS and SSS	Urban	0	0	0
255	GOVERNMENT GIRLS SCIENCE COLLEGE, TUNGA MAGAJIYA	Tungan-Magajiya	RIJAU	Public	SSS ONLY	Rural	0	207	207
256	GOVERNMENT SECONDARY SCHOOL RIJAU	Rijau	RIJAU	Public	JSS and SSS	Rural	307	0	307
257	MUHAMMAD BAWA RIJAU VOCATIONAL TRAINING CENTRE, RIJAU	Rijau	RIJAU	Public	SSS ONLY	Urban	48	13	61
258	BODO SECONDARY SCHOOL KUTA	Kuta	SHIRORO	Public	JSS and SSS	Rural	95	66	161
259	DAY SECONDARY SCHOO,L SHE	She	SHIRORO	Public	JSS and SSS	Rural	67	78	145
260	DAY SECONDARY SCHOOL BASSA	Bassa	SHIRORO	Public	JSS and SSS	Rural	95	63	158
261	DAY SECONDARY SCHOOL CHIRI	Chiri	SHIRORO	Public	JSS and SSS	Rural	28	18	46
262	DAY SECONDARY SCHOOL GURMANA	Gurmana	SHIRORO	Public	JSS and SSS	Rural	17	15	32
263	DAY SECONDARY SCHOOL KOBWA KUTA	Kubwa-Kuta	SHIRORO	Public	JSS and SSS	Rural	70	100	170
264	DAY SECONDARY SCHOOL KPMAKPMA	Kpmakpma	SHIRORO	Public	JSS and SSS	Rural	35	39	74
265	DAY SECONDARY SCHOOL MANTA	Manta	SHIRORO	Public	JSS and SSS	Rural	103	60	163
266	DAY SECONDARY SCHOOL PINA	Pina	SHIRORO	Public	JSS and SSS	Rural	30	5	35
267	DAY SECONDARY SCHOOL SHAKWATU	Shakwatu	SHIRORO	Public	JSS and SSS	Rural	55	55	110
268	DAY SECONDARY SCHOOL SHIRORO NEPA	Shiroro	SHIRORO	Public	JSS and SSS	Rural	223	120	343
269	DAY SECONDARY SCHOOL, TAWALI	Tawali	SHIRORO	Public	JSS and SSS	Rural	234	182	416
270	DAY SECONDARY SCHOOL, TUMTUM-KUTA	Tumtum-Kuta	SHIRORO	Public	JSS and SSS	Urban	150	56	206
271	GIRLS DAY ESCONDARY SCHOOL, KUTA	Kuta	SHIRORO	Public	JSS and SSS	Urban	0	95	95
272	GOVERNMENT DAY SECONDARY SCHOOL ERENA	Erena	SHIRORO	Public	JSS and SSS	Rural	98	85	183
273	GOVERNMENT DAY SECONDARY SCHOOL, GUSSORO	Gussoro	SHIRORO	Public	JSS and SSS	Rural	30	25	55
274	GOVERNMENT SCIENCE COLLEGE KUTA	Kuta	SHIRORO	Public	JSS and SSS	Urban	61	28	89

275	GOVERNMENT SECONDARY SCHOOL ALLAWA	Allawa	SHIRORO	Public	JSS and SSS	Rural	55	15	70
276	WOMEN DAY COLLEGE KUTA	Kuta	SHIRORO	Public	JSS and SSS	Urban	0	35	35
277	COMMAND SECONDARY SCHOOL	Suleja	SULEJA	Public	JSS and SSS	Urban	98	85	183
278	COMMUNITY SECONDARY SCHOOL	Suleja	SULEJA	Public	JSS and SSS	Urban	276	268	544
279	GIRLS DAY SECONDARY SCHOOL	Suleja	SULEJA	Public	JSS and SSS	Urban	0	498	498
280	GOVERNMENT DAY SECONDARY SCHOOL KWAMBA	Kwamba	SULEJA	Public	JSS and SSS	Urban	189	298	487
281	GOVERNMENT DAY SECONDARY SCHOOL MADALLAH	Madallah	SULEJA	Public	JSS and SSS	Urban	478	496	974
282	GOVERNMENT DAY SECONDARY SCHOOL MAJE	Maje	SULEJA	Public	JSS and SSS	Urban	11	16	27
283	GOVERNMENT MODEL SCIENCE COLLEGE	Suleja	SULEJA	Public	JSS and SSS	Urban	481	587	1068
284	SULEIMAN BARAU TECHNICAL COLLEGE	Suleja	SULEJA	Public	SSS ONLY	Urban	255	142	397
285	WOMEN DAY COLLEGE SULEJA	Suleja	SULEJA	Public	JSS and SSS	Urban	0	77	77
286	BASIC EDUCATION SECONDARY SCHOOL	Suleja	SULEJA	Public	ALL LEVELS	Urban	10	8	18
287	DAY SECONDARY SCHOOL BABBANTUNGA	Babban-tunga	TAFA	Public	JSS and SSS	Rural	109	60	169
288	GOVERNMENT DAY SECONDARY SCHOOL GARAM	Garam	TAFA	Public	JSS and SSS	Rural	133	133	266
289	GOVERNMENT DAY SECONDARY SCHOOL GAURAKA	Gauraka	TAFA	Public	JSS and SSS	Urban	227	215	442
290	GOVERNMENT DAY SECONDARY SCHOOL SABON WUSE	Sabon-Wuse	TAFA	Public	JSS and SSS	Rural	240	294	534
291	GOVERNMENT DAY SECONDARY SCHOOL SABON BWARI	Sabon-Bwari	TAFA	Public	JSS and SSS	Rural	39	37	76
292	GOVERNMENT GIRLS SCIENCE COLLEGE SABON WUSE	Sabon-Wuse	TAFA	Public	SSS ONLY	Urban	0	291	291
293	GOVERNMENT SECONDARY SCHOOL IJA GWARI	Ija-Gwari	TAFA	Public	JSS and SSS	Rural	110	90	200
294	GOVERNMENT VOCATIONAL TRAINING CENTRE	Sabon-Wuse	TAFA	Public	SSS ONLY	Urban	242	38	280
295	GOVERNMENT SECONDARY SCHOOL, KALIKO	Kaliko	WUSHISHI	Public	JSS and SSS	Rural	70	25	95
296	GOVERNMENT SECONDARY SCHOOL, MAITO	Maito	WUSHISHI	Public	JSS and SSS	Rural	31	4	35
297	WOMEN DAY COLLEGE, WUSHISHI	Wushishi	WUSHISHI	Public	JSS and SSS	Urban	0	45	45
298	GOVERNMENT DAY SECONDARY SCHOOL, LOKOGOMA	Lokogoma	WUSHISHI	Public	JSS and SSS	Rural	28	14	42
299	GOVERNMENT SECONDARY SCHOOL, WUSHISHI	Wushishi	WUSHISHI	Public	JSS and SSS	Urban	180	165	345
300	GOVERNMENT GIRLS SCIENCE COLLEGE, ZUNGERU	Zungeru	WUSHISHI	Public	JSS and SSS	Rural	0	73	73
301	GOVERNMENT DAY SECONDARY SCHOOL, ZUNGERU	Zungeru	WUSHISHI	Public	JSS and SSS	Rural	218	48	266
302	SUCCESS ACADEMY PRIMARY AND NURSERY	Sabon-Wuse	TAFA	Rural	ALL LEVELS	Urban	12	10	22
							35092	26313	61405

SOURCE: 2019/2020 ASC REPORT

19/3/21

ISHAKU A. NDA

DIRECTOR PLANNING, RESEARCH AND STATISTICS

DIRECTOR (PRS)

SIGN

DATE 19/3/21

MIN OF EDUCATION

APPENDIX H

LESSON PLAN

CONTROL GROUP

LESSON ONE

CLASS: SS II

SUBJECT: MATHEMATICS

TOPIC: QUADRATIC EQUATION

(i) SUB-TOPIC: SOLVING USING COMPLETING THE SQUARE METHOD

TIME: 8:00 – 8:40

DURATION: 40 MINUTES

AVERAGE AGE OF STUDENTS: 17YEARS

BEAHVIOURAL OBJECTIVES: By the end of the lesson student should be able to:

(ii) Outline the steps involved in using completing the square method
(iii) Use the method to solve quadratic equation

ENTRY BEHAVIOUR: The students have learnt how to solve linear equations, perfect square, factorization method of solving quadratic equations.

INSTRUCTIONAL MATERIAL: Chalkboard/Marker.

Content Development	Strategies	Teaching Activities	Student Activity
Introduction	Questioning	The teacher introduces the topic by asking the student	Student attempt to answer the questions

		questions based on the previous knowledge, what is quadratic equation	
Overview on completing the square method	Explanation and illustration	completing the square method is technique that helps us to solve quadratic equations. A Quadratic Equation is an equation of the form (or equivalent to) $ax^2 + bx + c = 0$ where a, b and c are real numbers Step 1 Divide all terms by a (the coefficient of x^2). We have $x^2 + \left(\frac{b}{a}\right)x + \frac{c}{a} = 0$ Step 2: Move the number term (c/a) to the right side of the equation. We have $x^2 + \left(\frac{b}{a}\right)x = -\frac{c}{a}$ Step 3 Complete the square on the left side of the equation and balance this by adding the half square of the coefficient of x to the right and left side of the equation. $x^2 + \left(\frac{b}{a}\right)x + \left(\frac{b}{2a}\right)^2 = -\frac{c}{a} + \left(\frac{b}{2a}\right)^2$ this can be written as $\left(x + \frac{b}{2a}\right)^2 = -\frac{c}{a} + \left(\frac{b}{2a}\right)^2$ Step 4 Take the square root on both sides of the equation. $\left(x + \frac{b}{2a}\right) = \pm\sqrt{-\frac{c}{a} + \left(\frac{b}{2a}\right)^2}$ Step 5 Subtract the number that remains on the left	The student listen and follow up with teachers. And ensure they conform with the stated facts.

		side of the equation to find x. $x = -\frac{b}{2a} \pm \sqrt{-\frac{c}{a} + \left(\frac{b}{2a}\right)^2}$	
Apply the method	Illustration	Solve $x^2 + 4x + 1 = 0$ Coefficient of x^2 is 1; x is 4 Step 1 Divide all through coefficient of x^2 which is 1 We have $x^2 + 4x + 1 = 0$. Step 2 Move the number term to the right side of the equation: $x^2 + 4x = -1$. Step 3 Complete the square on the left side of the equation and balance this by adding the half square of the coefficient of x to the right and left side of the equation. $= (4/2)^2 = 2^2 = 4$ $x^2 + 4x + 4 = -1 + 4$ $(x + 2)^2 = 3$ Step 4: Take the square root on both sides of the equation: $x + 2 = \pm\sqrt{3} = \pm 1.73$ (to 2 decimals) Step 5: Subtract 2 from both sides: $x = \pm 1.73 - 2 = -3.73$ or -0.27	The students follows the steps as illustrated by the teacher and the application of completing the square method.
Apply the method	Illustration	Solve $5x^2 - 4x - 2 = 0$ Coefficient of x^2 is 5; x is- 4 Step 1 Divide all terms by 5 We have $x^2 - 0.8x - 0.4 = 0$ $= (0.8/2)^2 = 0.42 = 0.16$ $x^2 - 0.8x + 0.16 = 0.4 + 0.16$ $(x - 0.4)^2 = 0.56$	The students follows the steps as illustrated by the teacher and the application of completing the square method.

		Step 4 Take the square root on both sides of the equation: x – 0.4 = ±√0.56 = ±0.748 (to 3 decimals) Step 5 Subtract (-0.4) from both sides (in other words, add 0.4): x = ±0.748 + 0.4 = -0.348 or 1.148.	
Evaluation	Questioning	The teacher gives the student s the following class work to do i. $x^2 - 6x + 12 = 0$	The student attempt to answer the class work
Summary and Conclusion	Explanation	The teacher revises topic and marks the students' class work	

Assignment: Solve the $2x^2 - 8x - 20 = 0$

LESSON PLAN

CONTROL GROUP

LESSON TWO

CLASS: SS II

SUBJECT: MATHEMATICS

TOPIC: QUADRATIC EQUATION

(iv) SUB-TOPIC: SOLVING USING FORMULA METHOD

TIME: 8:00 – 8:40

DURATION: 40 MINUTES

AVERAGE AGE OF STUDENTS: 17YEARS

BEAHVIOURAL OBJECTIVES: By the end of the lesson student should be able to:

(v) Outline the steps involved in using completing the square method
(vi) Use the method to solve quadratic equation

ENTRY BEHAVIOUR: The students have learnt how to solve linear equations, perfect square, factorization method of solving quadratic equations.

INSTRUCTIONAL MATERIAL: Chalkboard/Marker.

Content Development	Strategies	Teaching Activities	Student Activity
Introduction	Questioning	The teacher introduces the topic by asking the student questions based on the previous knowledge, what is quadratic equation	Student attempt to answer the questions

Overview on completing the square method	Explanation and illustration		In our last lesson, we learnt about the basic quadratic concepts and solving using factorization method. The quadratic formula is a way for us to easily calculate the zero's or 'roots' of a quadratic equation, and equation whose highest x power is 2. Restated this gives us the x-values that when put into the original equation outputs zero. To derive the quadratic formula we first start with a quadratic equation whose output is set to zero $ax^2 + bx + c = 0$. As we can not make the assumption that this quadratic equation is a perfect square we must complete the square. To do this we first get rid of the a coefficient on x^2 and move $\frac{c}{a}$ to the other side giving us $ax^2 + \frac{b}{a}x = -\frac{c}{a}$,. We can substitute $d=\frac{b}{a}$ and complete the square by adding $\left(\frac{d}{a}\right)^2$ to both sides $x^2 + dx + \left(\frac{d}{a}\right)^2 = \left(\frac{d}{a}\right)^2 - \frac{c}{a}$,. from our knowledge of completing the square we can rewrite the left side ending with $\left(\frac{d}{2}\right)^2$ $\left(x + \left(\frac{d}{a}\right)\right)^2 = \left(\frac{d}{a}\right)^2 - \frac{c}{a}$,.. Simplifying the right side we get $\left(x + \left(\frac{d}{a}\right)\right)^2 = \left(\frac{d^2a-4ac}{4a}\right)$ which further simplifies to $\left(x + \left(\frac{d}{a}\right)\right)^2 = \left(\frac{d^2}{4} - \frac{c}{a}\right)$,.. Substituting back $d = \frac{b}{a}$ and taking the square root of both sides we get $x + \left(\frac{b}{2a}\right) = \pm\sqrt{\frac{b^2}{4a^2} - \frac{c}{a}}$ working with the terms under the square root we can put them over a common denominator and arrive at which further simplifies to *b* . Substituting $\left(x+\left(\frac{d}{2}\right)\right)^2=\left(\frac{d^2}{4}-\frac{c}{a}\right)$	The student listens and follow up with teachers. And ensure they conform with the stated facts.

		back $d = \frac{b}{a}$ and taking the square root of both sides we get $x + \left(\frac{b}{2a}\right) = \pm\sqrt{\frac{b^2}{4a^2} - \frac{c}{a}}$ Working with the terms *a* under the square root we can put them over a common denominator and arrive at $x + \left(\frac{b}{2a}\right) = \pm\sqrt{\frac{b^2-4ac}{4a^2}}$ The denominator is a square and can be moved out *x* of the radical and we can subtract $\left(\frac{b}{2a}\right) =$ from both sides to finally solve for *x* which gives $x = -\frac{b}{2a} \pm \frac{\sqrt{b^2-4ac}}{2a}$. Last we combine both terms on the right side to obtain the quadratic formula $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$	
Apply the method	Illustration	solve (a) $x^2 + 3x + 2 = 0$ Compare above equation with $ax^2 + bx + c = 0$ where, a = 1, b = 3 , c= 2 then, solve for *x,* By using formula method $x = \frac{-3\pm\sqrt{3^2-4\times1\times2}}{2\times1}$ $x = \frac{-3\pm\sqrt{9-8}}{2}$ $x = \frac{-3\pm\sqrt{1}}{2}$	The students follows the steps as illustrated by the teacher and the application of completing the square method.

		$x = \frac{-3\pm1}{2}$ $x = \frac{-3+1}{2} = 1$ or $x = \frac{-3-1}{2} = \frac{-4}{2} = -2.$ Hence, the roots of equation are 1and -2	
Apply the method	Illustration	Solve (b) $x^2 + 4x + 3 = 0$ Compare above equation with a$x^2 + bx + c = 0$ where, a = 1, b = 4, c= 3 then, solve for *x,* by using formula method $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$ $x = \frac{-4\pm\sqrt{4^2-4\times1\times3}}{2\times1}$ $x = \frac{-4\pm\sqrt{16-12}}{2}$ $x = \frac{-4\pm\sqrt{4}}{2}$ $x = \frac{-4\pm2}{2}$ $x = \frac{-4+2}{2} = -1$ or $x = \frac{-4-2}{2} = \frac{-6}{2} = -3.$ Hence, the roots of the equation are -1 and -3	The students follows the steps as illustrated by the teacher and the application of completing the square method.
Evaluation	Questioning	The teacher gives the student s the following class work to do ii. $2x^2 - 8x - 20 = 0$	The student attempt to answer the class work
Summary and Conclusion	Explanation	The teacher revises topic and marks the students' class work	

Assignment: Solve the $x^2 - 6x + 12 = 0$