UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF CONSTRUCTIVIST TEACHING APPROACHES ON JUNIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE, RETENTION AND ATTITUDE IN ALGEBRA

SALAWU ISAH SEZUO

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DECLARATION

Student's Declaration

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

Signature: ……………………………

Date: …………………………………

Supervisor's Declaration

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

Prof. C. K. Assuah (Supervisor)

Signature: ……………………………

Date: …………………………………

DEDICATION

To my lovely wife, Sikirat Oyiza Salawu (Mrs.), for holding the home front intact whenever I am away.

ACKNOWLEDGEMENT

To the glory of Almighty Allah for the wisdom and capacity that saw me through all the phases of the project.

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Finally, I am thankful to all persons who in various ways, have made inestimable contributions to this study from its commencement to the conclusion.

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ABSTRACT

The purpose of this study was to investigate the effect of constructivist teaching approaches on junior secondary school students' performance, retention and attitude in Algebra within Okene Metropolis of Kogi State in Nigeria. The study leveraged on constructivism theory which posits learners construct knowledge rather than just passively take in information. The study utilized a quasi-experimental design which adapts the pre-test, post-test, post post-test on Experimental Groups and Control groups. A sampling size of 600 out of 54,490 was selected using multi-stage sampling technique. Three research questions were raised and tested with three null hypotheses. One of the major results showed that the students taught with the constructivist teaching approaches have significantly higher score than those taught with lecture method. The major implication of the study for teaching and learning of Algebra in particular, and Mathematics in general, is that learner-centred teaching approaches leads to better performance of students. The study concluded that the use of constructivist teaching approaches (Activity-Based, Guided-Discovery and Problem-Solving) have significant positive effects on academic performance, retention and attitude of junior secondary school students towards Mathematics. It was recommended that the teachers of Mathematics should collaborate with publishers to publish Algebraic books written with the principles of constructivists teaching approaches. Teachers, curriculum planners and stakeholders in Education should include samples of lesson note on how to teach Mathematics with constructivist approaches during Curriculum Reviewed, Workshops, Seminars, etc.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This introductory chapter discusses the background to the study, statement of the problem, the purpose of the study, the objectives, research questions, the hypotheses, significance of the study, basic assumptions, scope/delimitation of the study, and operational definitions.

1.1 Background to the Study

Nations, the world over see Mathematics as a vehicle for effecting economic, social, political scientific and technological changes (Kajuru, 2010). Thus Mathematics is given adequate attention and emphasis in the Nigerian school curriculum, right from primary through secondary to tertiary institutions. It is compulsory subject for students before gaining admission into tertiary institutions in the country. Suffice to say therefore that Mathematics has an important role to play in the task of nation building and development. Hence Ibrahim (2012) described Mathematics as the queen, the servant and language of the sciences.

Passing examinations at all cost by students to secure unmerited certificates, is to many people the goal of going to school rather than acquiring useful knowledge, skills and experience with which to cope with the demands of modern and real life. This negative mindset has made success in public examinations a do-or-die affair amongst students (Kajuru, 2010).

Nigeria, as a developing nation, has formulated many educational policies and programmes under the umbrella; National Policy on Education (FME, 2014). The major aim of the constant review of the nation's education policies and programmes is to address inherent mistakes in the existing ones and meet up the world best practice. This National Policy on Education identified the following as the causes of poor performance of students in public examinations: the use of archaic teaching methods, lack of instructional materials, over-crowded classroom, poorly or untrained teachers, just to mention but this few.

Of the above factors, archaic teaching method accounts most for the poor performance in Mathematics and other core subjects like English Language. According to Ochepa (1999), most teachers of Mathematics at secondary school level stick to only lecture method and in most cases, teachers do most of the talking and leave the students as passive listeners. Roberto (2004) went further to say that the focus is on the teacher and what is being taught. Every learner is forced to learn at the same rate and speed. No consideration for slow learners. Learner is subjected to memorize formulae, abstracts, and facts. Therefore, this research work was focus on these archaic methods that caused the poor performance of Nigerian students in Mathematics.

1.2 Statement of the Problem

Nigerian students' massive failure in Mathematics is disturbing. Despite the effort of the government, teachers, and other education stakeholders including students, it is regrettable that many students continue to struggle with Mathematics and perform low in both school-based and national examinations (Zakariya et al., 2016). This is evident in the persistent students' low performance in national examinations such as the Senior Secondary School Certificate Examinations that are conducted by both the West African Examinations Council (WAEC) and National Examinations Council (NECO).

For instance, the results obtained from the examinations division of WAEC in a state in Nigeria reveal that the percentage of students that obtained credit pass and above in Mathematics from 2005 to 2015 was between 4% and 15% (Ginga & Zakariya, 2020).

This poor performance is heavily blamed on the teacher-centred pedagogy used in teaching Mathematics. For instance, Emaikwu (2012) stated that inadequacy of conventional teaching models used by Mathematics teachers reduce students' interest, achievement and retention ability. Azuka (2003) and Missildinel (2004) cited by Muhammed (2017), commented on the ways, manner and approaches used by Nigerian Mathematics teachers as inappropriate. They remarked that low achievement in Mathematics is caused by the teachers' non-utilization of appropriate teaching approaches to Mathematics. Besides, Ado (2014) opined that little attention is paid to the students' attitude towards Mathematics vis-à-vis their performance.

Meanwhile, multiple studies have suggested that adopted instructional strategies in schools contribute immensely to students' learning outcomes. In a quasi-experiment conducted by Ginga and Zakariya (2020), they found that social constructivist instructional strategy is effective and leads to improved performance of students learning algebra better than the use of conventional method of teaching. However, none of these promising reported efficacies of the innovative teaching and learning strategies focused on secondary school students in Okene Metropolis, Kogi State of Nigeria.

At the junior secondary school level, students were introduced to an aspect of Mathematics called Algebra. According to Gambari (2014), basic Algebra is one of the branches of Mathematics that teachers find difficult to teach and students find difficult to learn due to its abstract nature. Therefore, Nabie (2002) states that the place of

Mathematics in scientific advancement suggests that every effort should be made to eliminate children's learning difficulties in the subject at early years when foundation concepts are formed. In line with Nabie's submission, constructivist teaching strategies will surely eliminate students learning difficulties in Algebra due to being student-centred approaches.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of constructivist approaches to teaching on junior secondary school students' performance, retention and attitude in Algebra within Okene metropolis of Kogi State, Nigeria.

1.4 Objectives of the Study

Objectives of this study were:

i. to investigate the effect of constructivist approaches to teaching on junior secondary school students' performance in Algebra.

ii. to investigate the effect of constructivist approaches to teaching on junior secondary students' retention in Algebra.

iii. to investigate the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra.

1.5 Research Questions

The following research questions were formulated.

i. What is the effect of constructivist approaches to teaching on junior secondary school students' performance in Algebra?

ii. What is the effect of constructivist approaches to teaching on junior secondary school students' retention in Algebra?

iii. What is the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra?

1.6 Null Hypothesis

The following hypotheses were formulated and tested at 0.05 level of significance:

(i) Ho_1: There is no significant difference between the academic performance of students who were taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

(ii) Ho_2: There is no significant difference between the retention of students who were taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

(iii) Ho_3: There is no significant difference between the attitude of students taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

1.7 Significance of the Study

The Nigerian public today is on high demand that the nation's schools provide effective education to keep pace with a rapidly changing world in all ramifications. Going by the roles of Mathematics towards national development, there is the need for improvement in the teaching and learning processes of the subject. Therefore, the findings of this study would hopefully provide the following benefits:

Significant to students

It would give the students a lot of benefits on the short and long term basis. Being a learner-centred method, it would provide the students easy understanding of difficult concepts. Besides, the students get more involved, free to explore situation on their own and discover new knowledge which enhances permanent learning.

Significant to teachers

On the part of the teachers, it would provide additional resources and options to use and provide the ability to present difficult concepts to their students. It equally encouraged the local production of instructional materials by teachers while carrying along their students.

Significant of other stakeholders

Finally, it would be significant to education stakeholders like, curriculum planners, mathematics text publishers, school inspectors, mathematics and none governmental organizations.

1.8 Basic Assumptions

The following are the basic assumptions made for the study:

1. Teachers used in these schools are qualified to teach Algebra at this level.
2. The schools under study are similar based on curriculum contents and syllabus used.
3. The students that were used for the study have covered the junior secondary schools 1 Mathematics curriculum and as such familiar with Algebra concepts in Book 1.

4. The students that were used for the study were not familiar with the constructivist approaches.

1.9 Scope/Delimitation of the Study

The study was restricted to public junior secondary school students in Okene Metropolis because they were averagely the same, found in the same area and received the treatment at the same time from the teachers.

The instrument used for the study is Algebra Performance Test (APT) aimed at measuring students' performance, retention and attitudes. The study also sought to compare constructivist approaches with the conventional teaching/learning strategy as they affect academic performance, retention and attitudes of the students in classroom environments in Nigeria.

The selected Mathematics topics in Algebra used for the study were taken from the National Education and Research Development Council (NERDC) curriculum for JSS II based on a 3-term, 10 weeks per term in the school year. The selected junior secondary schools from the Okene Educational Metropolis are all public schools. These are: FCE Demonstration Secondary Schools, Okene; Government Science Secondary School, Ogaminana and Ihima Community Secondary School, Ihima; with at least a school from each of three Local Government Areas within Okene Metropolis.

The research work was not able to cover the entire schools in the three Local Government Areas (Okene, Okehi and Adavi LGAs). Besides, privately owned secondary schools were not considered because the researcher wanted to ascertain uniformity in the experiment.

1.10 Limitation

1. The fact that most mathematics teachers are used to the conventional lecture teaching method, it took the researcher time and resources to put them through constructivist teaching strategies. However, this didn't affect the outcome of the study for it amounted to mere retraining for them.
2. Nigeria was just coming out of covid-19 lockdown when the study was carried out. Some of the covid-19 protocols were still in place. This led to usage of more classrooms to maintain distance. On the whole, teaching and testing were carried out smoothly.
3. The study could not cover all the schools in Okene metropolis. Due to sound sampling technique and statistics employed, the outcome wasn't any way affected.

1.11 Operational Definitions of Terms

Constructivism: Constructivism is the theory of education that says learners construct knowledge rather just passively take in information.

Lecture method: Lecture method is teacher controlled and information centred approach in which teacher works as a role resource in classroom instruction. In this method, the teacher only does the talking and the student is a passive listener. This is the oldest method of teaching which is based on philosophy of idealism.

Academic Performance: According to Nard and Abdullahi (2016), academic performance is the knowledge gained which is assessed by marks by a teacher and/or educational goals set by students and teachers to be achieved over a specific period of time.

Retention: Retention is the act of continuing to possess, control of hold something in memory.

Attitude: Attitude is a settled way of thinking or feeling about something.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter presents the review of related literature relevant to the study. Thematic areas covered include the theoretical framework, conceptual framework, problem-solving, guided-discovery, activity-based, conventional teaching method, performance of students in Algebra, retention of students in Algebra, attitude of students towards Algebra, overview of related studies and implications of literature reviewed on the present study.

2.1 Conceptual Framework

Constructivism is based on the idea that knowledge or concept is constructed by the learner-based mental activity (Skinner, 2002). Constructivist conceptual framework holds that learning always builds upon knowledge that students already acquired. It suggests that learning is more effective and motivating when students are actively engaged in the learning process rather than attempting to receive knowledge passively. In this case, teaching methods such as guided-discovery, activity-based and problem-solving strategies fit into the constructivist conceptual framework. Thus, Okebukola (2002) observed that many of the instructional strategies proposed to improve science instruction are those using constructive view.

Constructivist approach is equally regarded as child-centred approach. Roger (2004) described child-centred learning approach is aimed at enforcing children's self-esteem, self-confidence and the development of a positive and realistic self-concept and thus aiming at enhancing individual empowerment and the capacity to organise oneself for future development. Furthermore, this approach aims at creating an environment which allows respect for characteristics and sometimes differing cultural features. By using a child-centred approach, teachers try to accommodate and support every individual child and its specific needs and possibilities.

Algebra comes from the Arabic word: al-jabr, meaning reunion of broken parts and bone setting (Menini, et al, 2017). The Persian Mathematician; Muhammed Ibn Musa al-Khwarizmi (780-850) wrote and published in 830 “The Compendious Book on Calculation by Completion and Balancing” which established algebra as a mathematical discipline that is independent of geometry and arithmetic (Roshidi Rasheed, 2009). Al-Khwarizmi’s contribution was fundamental. He solved Linear and Quadratic equations without algebraic symbolism, negative numbers or zero. Thus, he had to distinguish several types of equations. Therefore, in the context of identification with rule for manipulating and solving equations, al-Khwarizmi is regarded as “the Father of Algebra” (Christiandis, 2007).

Boyer (1991) pointed out too that al-Khwarizmi introduced the method of ‘reduction and balancing’ (i.e. the transposition of subtracted terms to the other side of the equation leading to cancellation of like-terms in opposite sides of the equation) which the term al-jabr originally referred to: Elementary algebra is the most basic form of algebra. It is taught to students who are presumed to have no knowledge beyond basic principles of arithmetic. Unlike in arithmetic where only numbers and their arithmetical operations (such as +, -, x, ÷) occur, in algebra, numbers are often represented by symbols called variables (such as a, n, x, y or z). It has been suggested that elementary algebra should be taught to students as young as eleven years old

(Hull's Algebra, 2012). In Nigeria, algebra is introduced to students as from Junior Secondary School 1 (i.e. 12 years).

Algebra at Junior Secondary level serves as a background for understanding all branches of Algebra at higher level. Gambari (2014) states that basic algebra is one of the branches of Mathematics that teachers find difficult to teach and students find difficult to learn. There is the need to give it special attention through the use of appropriate teaching methods like discovery, demonstration and problem-solving strategies. Azuka (2003) cited in Muhammed (2017) commented on the ways, manners and approaches used by Nigerian Mathematics teachers as inappropriate. They further remarked that low achievement in Mathematics is primarily caused by the teachers' non-utilization of appropriate teaching approaches to Mathematics.

2.2 Theoretical Framework

This study underpinned with constructivist school of thought which believed in human personal and self-educational developments. The constructivist theory posits that knowledge can only exist within the human mind, and that it does not have to match any real world reality. Constructivism is the theory that says learners construct knowledge rather than just passively take in information. In other words, it is a learner-centred teaching approach. Therefore, the role of teacher is like a guide and observer/facilitator to the child to grow naturally. Brown (2013) indicates that the beginning of the social constructivist movement in America was partially influenced by John Dewey who wrote "Democracy and Education" in 1916.

Modern teaching method in education is child-centred, the exact mandate of constructivism. Sambo (2005) is of the view that the most important nature of constructivist approach is interest, student-centred, activity-based retentive and lead the students to have Mathematical power. Constructivist approach assumed that the learners came to the class with their experiences. The teacher's role is to guide and encourage the student. The students are actively involved in the learning activities thus they are active learners.

Philosophically, constructivist approach is a learning process founded on the premise that by reflecting on our experiences, we can construct our own understanding of the world around us. Ogawa (2001) in Ohisen (2007) described constructivism as an epistemology; a theory of knowledge related to objectivism, where knowledge is viewed as existing outside the bodies of cognizing beings. Constructivism simply means that people have the ability to construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Ahmed, 2019). Constructivism emphasizes the building (construction) that occurs in learners mind when they learn new concepts. Therefore, students learn faster and achieve better retention when learning is based on problem-solving activity.

Constructivism is also referred to as child-centred teaching method. In child-centred approach, the child progresses at his or her own speed. The teaching and learning of the child depends on the child's interest and needs. The learning content is developed along the child's social, spiritual and physical development of the child. These philosophers in favour of child-centred approach maintained that the child needs to have freedom to discover things than getting second-hand information through books and other non-print media.

From the concept of constructivism approach, educational psychologists and curriculum experts came up with several instructional models designed to address the inherent problems or difficulties in existing instructional models. The contemporary Biological Science Curriculum Study (BSCS) 5E instructional model, one of constructivist models, was developed by Atkins& Karplus 92002) cited by Bybee, Taylor, Gardiner, Scotter, Powell, Westbrook, and Lande (2006). This is of great importance to this study. The BSCS 5E instructional model has the following 5 steps:

- **Engagement** – object, event or question used to engage students.
- **Exploration** – objects and phenomena are explored hands-on activities with guidance.
- **Explanation** – students explain their understanding of concepts and process. New concepts and skills are introduced as conceptual clarity and cohesion are sought.
- **Evaluation** – activities allow students to apply concepts in contexts and build on or extend understanding and skills.
- **Evaluation** – students assess their knowledge, skills and abilities. Activities permit evaluation of student's development and lesson effectiveness.

The 5E model enables learning a new concept or trying to understand a concept that has been known in-depth. Students use their previous knowledge to discover new concepts. This model also includes student activity at every stage or step. Ergin (2008) noted that 5E model might be applied in education and social fields and that it is a method which turns education into a funny pursuit as well as ensuring learning.

2.3 Types of Constructivist Approaches

2.3.1 Problem-Solving Approach

Problem solving is the act of defining a problem; determining the cause of the problem; identifying, prioritizing, and selecting alternatives for a solution; and implementing a solution.

Why is it important? Employers like to see good problem solving skills because it also helps to show them you have a range of other competencies such as logic, creativity, resilience, imagination, lateral thinking and determination. It is a vital skills for your professional and personal life.

Modes of Problem Solving: Difference Between Question, Problems and Exercise

Question:

Question is something that can be answered. Sometimes, it can just be considered, Unanswered. A question can be usually followed by an answer or a sequence of questions that will finally lead anyone to an amazing answer involves mere recalling.

Problem:

Whereas a problem is something that needs to be solved, finding results, simplified by trial and error runs. Problems are usually done to practice with something so that the floss can be eliminated at a certain level. Problems ends up with a solution.

Problem-solving

Involves a process used to obtain a best answer to an unknown, subject to some constraints.

The situation is ill defined. There is no problem statement and there is some ambiguity in the information given. Students must define the problem themselves. Assumptions must be made regarding what is known and what needs to be found.

The context of the problem is brand new (i.e., the student has never encountered this situation before).

There is no explicit statement in the problem that tells the student what knowledge/technique/skill to use in order to solve the problem.

There may be more than one valid approach.

The algorithm for solving the problem is unclear.

Integration of knowledge from a variety of subjects may be necessary to address all aspects of the problem.

Requires strong oral / written communication skills to convey the essence of the problem and present the results.

Exercise Solving

Involves a process to obtain the one and only right answer for the data given.

The situation is well defined. There is an explicit problem statement with all the necessary information (known and unknown).

The student has encountered similar exercises in books, in class or in homework.

Exercises often prescribe assumptions to be made, principles to be used and sometimes they even give hints.

There is usually one approach that gives the right answer.

A usual method is to recall familiar solutions from previously solved exercises.

Exercises involve one subject and in many cases only one topic from this subject.

Communication skills are not essential, as most of the solution involves math and sketches.

Polya's Problem Solving Technique

Polya's Problem Solving Techniques In 1945 George Polya published the book How To Solve It which quickly became his most prized publication. It sold over one million copies and has been translated into 17 languages. In this book he identifies four basic principles of problem solving include

First Principle: Understand the problem

This seems so obvious that it is often not even mentioned, yet students are often stymied in their efforts to solve problems simply because they don't understand it fully, or even in part. Polya taught teachers to ask students questions such as:

- Do you understand all the words used in stating the problem?
- What are you asked to find or show?
- Can you restate the problem in your own words?
- Can you think of a picture or diagram that might help you understand the problem?
- Is there enough information to enable you to find a solution?

Polya's Second Principle: Devise a plan

Polya mentions that there are many reasonable ways to solve problems. The skill at choosing an appropriate strategy is best learned by solving many problems. You will find choosing a strategy increasingly easy. A partial list of strategies is included:

Polya's Third Principle: Carry Out the Plan

This step is usually easier than devising the plan. In general, all you need is care and patience, given that you have the necessary skills. Persist with the plan that you have chosen. If it continues not to work discard it and choose another. Don't be misled, this is how mathematics is done, even by professionals.

Polya's Fourth Principle: Look Back

Polya mentions that much can be gained by taking the time to reflect and look back at what you have done, what worked, and what didn't. Doing this will enable you to predict what strategy to use to solve future problems.

Muhammed (2017) states that problem-solving is a process of an ongoing activity in which we take what we know to discover what we don't know. it involves overcoming obstacles by generating hypotheses, testing those predictions, and arriving at satisfactory solutions. in order words, problem-solving is the ability to identify and solve problems by applying appropriate previously acquired skills systematically.

Atkins (2008) also said that problem-solving is, and should be, a very real part of the curriculum. Because, it presupposes that students can take on some of the responsibilities for their own learning and can take personal actions to solve problems, resolve conflicts, discuss alternatives, and focus on thinking as a vital element of the curriculum. Therefore, it provides students with opportunities to use their newly acquired knowledge in meaningful, real-life activities and assists them in working at higher levels of thinking. Atkins (2008) further stated that in a problem-solving method, children learn by working on problems to be solved. The students are expected to observe, understand, analyze, interpret, find solutions, and perform applications that lead to a holistic understanding of the concept.

This method helps develops scientific (Mathematics inclusive) process skills. It helps in developing brainstorming approach to learning concepts. The students thinking on problems and their understanding of the science behind it is based on common sense. It does not start from textual knowledge. Rather, it proceeds from experiencing to gradually forming concepts through books at later stage. Thus it is a process from practice to theory, not vice-versa. Knowledge here is not a goal but a natural outcome of working on tasks. Students like in the real world and like to deal with concrete things where they can tough, feel, manipulate things then the method is useful in igniting the process of scientific learning.

A problem is a task for which problem-solving may be a purely mental difficulty or it may be physical and involve manipulation of data. The perform confronting it wants or needs to find a solution because the person has no readily available procedure for finding the solution. The person must make an attempt to find the solution. Problem-solving is the act of defining a problem, determining the cause of the problem; identifying, prioritizing and selecting alternatives for a solution; and implementing a solution. Therefore, problem-solving method aims at presenting the knowledge to be learnt in the form of a problem. it begins with a problematic situation and consists of continuous, meaningful, well-integrated activity (Muhammed, 2017).

The specific objectives of the problem-solving in science are:

i. willingness to try problems and improves their perseverance when solving problems;

ii. improve pupils self-concept with respect to the abilities to solve problems;

iii. make pupils aware of the problem-solving strategies;

iv. enable pupils aware of the value of approaching problems in a systematic manner.

v. it makes pupils aware that many problems can be solved in more than one way;

vi. improve pupils abilities to select appropriate solution strategies;

vii. improve pupils abilities to implement solution strategies accurately;

viii. improve pupils abilities to get correct answers to problems;

ix. develop pupils appreciation of the existence of problems and a desire to solve them;

x. develop pupils accumulation of the facts and data which are pertinent to the problems; and

xi. develop logical interpretation of the data supported by adequate valid experiences.

Tips for effective use of problem-solving method are:

i. ask questions and make suggestions; ask students to predict "what would happen if…" or explain why something happened. This will help them to develop analytical and deductive thinking skills. Do this by providing positive reinforcement to let students know when they have mastered a new concept or skill;

ii. do not fear group works; students can frequently help each other, and talking about a problem, helps them think more critically about the steps needed to solve the problem;

iii. help students understand the problems in order to solve problems; students need to define the end goal. if you succeed at helping students answer the questions "what?" and "why?", finding the answer to "how?" will be easier. Here students identify specific problems, difficulties or confusions. Do not waste times working through problems that students already understand;

iv. if students are unable to articulate their concerns, determine where they are having trouble. Identify specific concepts or principles associated with the problem-solving process. In a one-on-one tutoring session, ask the student to work his/her problem out loud. This slows down the thinking process, making it more accurate and allowing you to access understanding;

v. link errors to misconceptions; use errors as evidence of misconceptions, not carelessness or random guessing. Make an effort to isolate the misconception and correct it, then teach students to do this by themselves. We can all learn from mistakes. Try to communicate that the process is more important than the answer so that the student learns that if okay to not have an instant solution;

vi. model the problem-solving process rather than just giving students the answer. As you work through the problem, consider how a novice might struggle with the concepts and make your thinking clear. Provide only minimal assistance and only when needed to overcome obstacles;

vii. take enough time. Budget enough time for: understanding the problem and defining the goal, individually and as a class; dealing with questions from you and your students; making and finding, and fixing mistakes, and solving entire problems in a single session;

viii. teach within a specific context. Teach problem-solving skills in the context in which they will be used. Use real-life problems in explanations, examples, and exams. Do not teach problem-solving as an independent, abstract skill; and

ix. work as a facilitator. Teacher must keep in mind that this is a child-directed. He must be alert and active to arouse interest among students. Must provide democratic atmosphere. Teacher must provide situation for all students to come forward and contribute towards the success of the activity. (Atkins, 2008)

2.3.2 Guided-Discovery Approach

Discovery teaching strategy has been defined in different ways by different scholars. Alumba (2008) sees it as mental assimilation y which the individual learner learning of concept or principle resulted from physical and mental activity carried out by the learner. The teacher ensures that the students have a chance to form a concept by studying subjects before leading the students to form the generalization. Mandrin and Preckel (2011) describe enhanced discovery learning as a process that involves preparing the learner for the discovery learning task by providing the necessary knowledge needed to successfully complete said task. In this approach, the teacher not only provides the necessary knowledge required to complete the task, but also provides assistance during the task.

Besides, Mandrin and Preckel (2011) stated another aspect of enhanced discovery learning by allowing the learner to generate ideas about a topic along the way and then having students explain their thinking. A teacher who asks the students to generate their own strategy for solving a problem may be provided with examples on how to solve similar problems ahead of the discovery learning task. “The teacher might question students and help them formulate their thinking into general guidelines for estimation, such as start by estimating the sum of the highest place value numbers”. As others come to the front of the room to work their way through problems out loud, students can generate and test more rules.

New and innovative methods have become commonplace in schools, colleges and universities. One of these interesting methods of learning is discovery learning. Dean and Kuhu (2006) have promoted this kind of learning many times such that discovery learning is used in the classroom and during problem-solving exercises and educational programmes. Students will undergo discovery learning when they are looking at their own experiences and knowledge in their studies, and enquiring about further information (Funchs, et al, 2008).

Discovery learning is a kind of teaching that is based on the students finding things out for themselves, looking into problems, and asking questions. Essentially, it is all about students coming to their own conclusions and asking about things in their course that might not make particular sense. Obviously, as soon as enquiries are made, they can learn new things and hence will have become part of an innovative, thought-provoking and interesting educational journey. Discovery learning will also be used in terms of answering controversial and tricky questions, asking other people what they think, and generally discussing things. Experiments are also key to discovery learning. For instance, in sciences where students will be able to experience science right in front of them and discover things that may occur, which hence prompts them to ask their question 'WHY?' Thus discovery strategy is applicable to virtually all areas of teaching Mathematics and the types of activities the students are given are varying from topic to topic and the age and ability of the learners are put into consideration. As a matter of fact, discovery learning helps the learner to learn by doing, a very important ingredient towards the successful learning of Mathematics.

On the whole, one cannot but be in agreement with recent scholars of thought given a great deal of attention to educational methods in which the child is given room and freedom to discover thing within his/her environment for himself/herself. This basic principle is the major brainchild of the father of progressive school of thought, Rousseau (2000), cited in Atkins (2008). He postulates the theory of naturalism which emphasizes that the child's natural self be allowed to develop completely, unfettered by the restrictions usually placed upon it by the traditional school. The creative and discovery method of teaching and learning allows the teacher to be a facilitator of the learner who should be directed to find out what confronts him/her in the immediate environment so that she/he can create or discover own solutions.

2.3.3 Activity-Based Approach

Various activity-based teaching strategies have been employed for the purpose of improving the teaching and learning of basic science at the JSS level. These strategies include inquiry method, demonstration method, process approach, cooperate learning and laboratory activity method. (Usman, 2007). In December 2005, the National Council on Education (NCE) directed Nigerian Educational Council (NERDC) to carry out the assignment of reviewing and restructuring the then existing curriculum for primary and junior secondary schools to fit into 9 year basic education programme.

This 9 year basic education programme stipulated the child should spend 9 years in primary and junior secondary school levels.

Some of the problems encountered in teaching and learning of Algebra especially in the Mathematics education level can be attributed to so many factors such as poor management, teachers' attitude toward the teaching of Algebra and poor instructional methods and strategies used in teaching and learning of Algebra. Also, another is students' lack of interest in learning Mathematics.

Academic performance could be considered as how well the knowledge attained or skills developed during teaching learning process were effective. Adediwura and Tayo (2007) defined academic performance as the display of knowledge attained or skills developed in school subjects designated by test and examination scores or marks assigned by the subject teachers. Studies have identified some of the variables that affect students' academic performance to include individual inherent potentials in terms of intelligence and sociological factors (Adediwura & Tayo, 2007) and the teacher variable (Chief Examiner Report WAEC 2009, Okebukola, 2005). It also identified that the students not only perform poorly in the cognitive but also in the effective and psychomotor domains of the mathematics education objectives (Uzoechi, 2004).

In an era of standard-based reform in education, many believe the best way to raise student academic achievement is through improved teaching; (Porter & Caret, 2000). To that end, Porter and Brophy (1998) maintained that student learning can be improved only if teachers' practices are of high standard; however, they concluded many teachers are not prepared to implement practices that reflect high standards. Morakinyo (2003) believe that the falling level of academic achievement is attributable to teacher's non-use of verbal reinforcement strategy. Others found out that the attitude of some teachers on their job is reflected in their poor attendance to lessons, lateness to school, unsavory comments about student's performance that could damage the learner's ego, poor method of teaching and the likes affects students' academic performance.

Padmavathi (2013) as cited in Zekerya Akkus (2015), states that teachers of the 21st century should adopt innovative teaching techniques in place of traditional teaching methods and perspectives and stresses that activity-based teaching is one of these techniques. Activity-based teaching is a technique which uses before and after behaviour stimuli which have natural and meaningful relations with behaviours and environment, arouses functional and generalisable skills and activities based on the child's interests, and teaches individual goals embedded in routines and planned activities (Ozen & Ergenekon, 2011 as cited in Zekerya Akkus, 2015). In other words, activity-based learning is a teaching approach which includes all in-class and out-of class activities which will help students to reach desired goals, to gain value, attitude, knowledge, and skills, to foster their cognitive, affective, and motor skills and to actualize learning by doing. Within this context, activity-based teaching approach is student-centred and encourages students to learn on their own. Moreover, activity-based teaching allows everyone to learn regarding their own abilities and skills (Shah & Rahat, 2014 as cited in Zekerya Akkus, 2015). It enables students to participate in lessons and helps them to learn how to learn. Furthermore, it allows students to work with their peers and experts in their own learning settings. Students gain independent and critical thinking skills via activity-based teaching. Rillero (1994) as cited in Zekerya Akkus (2015) says, "a child best learns how to swim in water, similarly, a child best learns science by doing science”. This statement summarises the benefits of this approach.

Mandrin and Preckel (2011) said, that activity-based involves showing by reason or proof, explaining or making clear by use of examples or experiments. Simply put, activity-based means ‘to clearly show’ in teaching through demonstration. Activity-based often occur when students have a hard time connecting theories to actual practice or when students are unable to understand application of theories. According to Mandrin and Preckel (2010), the history of phenomenon activity-based concepts goes back to the careful observations of ancient Greek philosophers and natural philosophy. Socrates, Plato, and Aristotle attempted to carefully define words that included natural phenomena and objects. The modern scientific method often uses demonstrations that carefully describe certain processes and parts of nature in great detail. In science, often one demonstrates how an experiment is done and shows this to others. People can also communicate values and ideas through activity-based. This is often done in plays, movies, and film. Activity-based teaching strategy is an audio-visual explanation, emphasizing the important points of a product, process, or an idea. It is basically an activity which involves showing and doing for the benefit of the learners. The demonstration is generally used as a strategy but also frequently used in relation with other strategies to teaching and learning as a special technique. This strategy was used in this study.

2.4 Conventional Teaching Approach

Generally, the conventional teaching approach at primary, secondary and tertiary institutions in Nigeria is called lecture method. The assumption of this teaching approach is that the students came to the class as empty vessels (Roberto, 2004). In which case, the teacher is a reservoir of all knowledge. Therefore, it is a one way flow of information from the teacher to the students (Damodharan & Rengarajan, 2005). It is also called direct instruction with emphasis on learning procedures and it uses drills and memorization to reinforce and assess teaching/learning (Okebukola, 2002).

Furthermore, this conventional teaching method is regarded as a teacher-centred model. According to teacher-centred theory, the teacher is the centre of teaching and learning because he has been trained and it is the teacher that has the monopoly of knowledge (Ahmed, 2019). Therefore, he impacts the knowledge in the learner. Roberto (2004) went further to say that the focus is on the teacher and on what is being taught. Every learner is forced to learn at the same rate and speed. No consideration for slow learner. Learner is subjected to memorise formulas, abstracts and facts.

Regrettably, this is the most used teaching strategy by Mathematics teachers at both primary/secondary level. Etukudo (2006) stressed that most teachers of Mathematics at secondary school level do not use teaching aids; they stick to only conventional method; in most cases, teacher does most talk and leaves the student passive listeners. Also, Emaikuju (2012) stated that there is widespread concern among parents and considerable public about the methods used in the teaching at the secondary school level especially Mathematics in Nigeria. He added, inadequacy of conventional teaching models used by Mathematics teachers reduces students' interest, achievement and retention ability. Materials used for teaching by the teacher are based on the lecture notes and recommended texts. There is insufficient interaction with students in classroom.

Emphasis is on theory without any practical lesson. Learning is based on rote thinking. Marks are awarded by the teacher in class work and examination. Rartmar (2012) further states that teachers who adhere to traditional methods are influenced greatly by standard-based movement. All students are taught the same body of knowledge regardless of variations in developmental levels; all children are exposed to the same content at the same time. The objective is to ensure that there will be no academic gaps in what is taught. The teacher determines what ought to be taught. The classes often require strict discipline. Student success is judged in comparison with how well others do.

It is worth being mentioned that one of the major criticisms of teacher-centred method is that learners are not actively involved in the teaching/learning process, hence they are passive. Traditional educational approaches have resulted in a mismatch between what is taught to the students and industry needs. According to Roberts Di Napoli (2004), contents or subject matter learnt using teacher-centred are often times not relevant in modern society. on the other hand, he observed that contents learnt using child-centred approach are those relevant to the contemporary society. He equally observed that teaching methods are rigid in teacher-centred but flexible in child-centred, amongst others. Therefore, this teacher-centred conventional teaching approach was equally investigated in this study.

2.5 Performance of Students in Algebra

Performance can be defined as the quality of results produced by students as reflected in the quality of their examination scores (Musa, 2000). in recent years, that quality of most completers of educational institutions in Nigeria falls below the expected academic competence stated in the National Policy on Education (FGN, 2014). For example, Nigeria is still producing graduates with little problem-solving skills and slow analytical minds (Punch, 2015). This has been attributed largely to poor teaching methods by the teachers resulting from the poor quality teacher-education. The poor teacher-education can be traced back to 1977 introduction of Universal Primary Education (UPE). According to Ahmed (2019), the implementation of the UPE programmes required large number of trained Grade II teachers for successful take off, but regrettably was in short supply in 1977. To make-up for the short supply of these Grade II teachers, a teacher-education policy known as “crash programme” was introduced with admission requirement into Grade II Teachers’ Training Colleges lowered. On completion of the programme, all teacher trainees, whether passed, referred or failed, were offered automatic employment and deployed to primary schools (and some to secondary schools) as teachers. This resulted in half-baked teachers taken charge of classrooms and teaching became a profession for all comers.

Therefore, students resulted into various antisocial activities during public examinations. Many students engage themselves in many of such acts before, during and even after public examinations. These negative acts have become known in Nigerian education parlance as “examination malpractice”. Abbas (2006) listed the following as acts of cheating in public examinations:

(1) improper behaviour by candidates within and around the examination hall like verbal or physical assault or insults by candidates on supervisors or invigilators;

(2) irregularity that is adopting different procedures form those provided by the examination bodies like varying the time of examination; and

(3) dishonesty which involves leakage, impersonation, smuggling, copying, collusion, substitution, fraud, falsification of official documents and external assistance.

Akpata (1997) cited in Ahmed (2019) maintained that examination malpractice in Nigerian schools is caused by poor teaching by teachers who are either not knowledgeable or not dedicated. The effects of poor teaching methods on the academic performance of students, coupled with too much emphasis placed on examinations and certificates, made examination malpractices inevitable for students. Entry requirements into tertiary institutions for example, require at least five credit passes at WASSCE/SSCE in five different subjects, Mathematics and English Language inclusive, for admission into degree awarding institutions.

Non-degree awarding institutions (Polytechnics, Colleges of Education, Nursing schools etc.) require either four or three credit passes including Mathematics and English Language. Again, employers of low cadres labour (Federal and State Civil Service, parastatals, agencies, private sectors) as clerks, messengers, drivers, cooks, maids and so on require ordinary level pass in Mathematics and English Language. This importance placed on certificates therefore, made many candidates sitting for WASSCE/SSCE developed a 'do or die' psychological mindset. After all, they are examinations that determine not only their career but also their destiny. As such, they must be passed not at just any grade, but at a grade not lower than credit pass.

The hardest hit in all of these, are the two core subjects of Mathematics and English Language. In particular, Mathematics is seen as threatening as success and failure seen clear cut. Failure can be glaringly obvious unlike in other subjects which may require one's observation and opinion or views. The black and white nature of Mathematics causes panic and anxiety. As a result, students ignore the subject and would prefer to engage in other activities that they anticipate will result in reward and those they feel they tackle (Schunk, 1997). Nicolaidou and Philipou (2003) showed that negative attitudes are brought about by frequent repeated failures or difficulty in dealing with mathematical tasks which may persists if not remedied. Mato & Torre (2010), in a study with secondary school students, showed that those who are better academically have more positive attitudes towards Mathematics than those with low academic performance. Hence, repeated failure in Mathematics leads to unfavourable attitudes. Students' attitude towards learning of Mathematics may be considered as both input and outcome variable as attitude towards the subject can be related to educational achievement in ways that reinforce higher or lower performance. Those learners who are positive about the subject tends to do well and vice-versa (Maria, 2012).

Studies on the relationship between Mathematics achievement and some learner-related variables including; self-efficacy, beliefs regarding knowledge and attitudes towards Mathematics, showed that the students' beliefs regarding their academic performance capabilities in Mathematics were the strongest predictor of achievement in Mathematics. The better the student evaluated themselves in doing Mathematics, the higher their academic performance (Mensah, Okyere & Kuranche, 2013). The conceptions, attitudes, and expectations of students regarding Mathematics and Mathematics teaching have been considered to be very significant factors underlying their school experiences and achievements. The general conceptions determine the way students approach Mathematics tasks, in many cases, leading them into non-productive paths.

Ponte (2012) as cited in Muhammad (2017), showed that students have been found to hold a strong procedural and rule-oriented view of Mathematics and to assume that mathematical questions should be quickly solvable in just a few steps, the goal just being to get "right answers" and within the shortest time possible. For them, the role of the student is to receive mathematical knowledge and to be able to demonstrate so; the role of the teacher is to transmit this knowledge and to ascertain that students acquired it. Such conceptions may prevent the students of understanding that there are alternative strategies and approaches to many mathematical problems, different ways of defining concepts, and even different constructions due to different "starting points". Consequently, they may miss significant aspects of mathematical experience, including making connections between concepts and their applications. They may approach the tasks in the mathematical class with a very narrow frame of mind that keeps them from developing personal methods and build confidence in dealing with mathematical ideas.

According to Macnabs and Cummine (2016), Mathematics is viewed by most students as series of calculations that require the application of some set values and formulae that needs to be memorized. They start to think that Mathematics is complex and not understandable except for those who are talented. This results in psychological switch-off and students make no effort to understand and carry out activities as assigned by the subject teachers. The student gives up what he/she believes to be a vain effort and switches off completely to an extent that even the most carefully presented materials may prove unsuccessful.

Studies have shown however, that there is light at the end of this dark tunnel. Howie (2012) reviewed studies relating to students self-perceptions and academic achievement. His findings were that when students believed that their academic performance was a consequence of their own actions rather than the consequences of factors out of their control, they had better academic achievement. Some research also points to the fact that confidence results from mathematical ability (self-efficacy) a predictor for achievement in Mathematics (Flores, 2007). Students' beliefs about their competence and their expectation for success in school have been directly linked to their levels of engagement as well as their emotional states that promote or interfere with their ability to be academically successful (Schenkel, 2009). Those who feel incompetent in the subject tend to be more anxious and fearful in revealing their ignorance n class. They fear that learning will result in embarrassment and humiliation which in turn inhibits them from behaving in ways that might help them for avoiding classes and failing to do assignment.

Also, Carreno (2004) used student activity based method in his class. The teacher reported that there was a benefit of learning with his model through observing students behaviour. Furthermore, in a study conducted in Sokoto State, Nigeria, the researchers used cooperative learning to teach Geometry in Junior Secondary School III. The experimental group had higher post-test mean performance scores in Geometry construction than students taught using lecture method (control group). This reason for this is that the students in experimental group were stimulated to learn by seeing themselves in a group and also feel free to communicate and find the solution to their problems themselves. This prompted more attention by the students (Kajuru & Isah, 2014). In another study conducted using mathematical games to teach students' simple fraction indicated that the experimental group performed significantly better than students taught using the talk-and-chalk method (Odo & Ugwuda, 2014).

A study on student performance in solving algebraic problems for two groups conducted by Cooney (2002), students taught using constructivist methods (experimental group) had an easier time completing problems with fewer errors in their calculations which would lead to higher mathematical achievement. Therefore, Chung (2004) believed that student had better achievement when students were instructed using constructivist methods. However, Harrison (2015) pointed out that students' centred teaching becomes embroiled in attempting to meet the diversity of student learning needs. These diverse needs of learners will certainly pose a great challenge to the teacher. As the teacher struggles to address students' needs, the teacher attention is taken away from the subject. Also, lecture method has the advantage of covering a variety of topics to a large class (issue of class size) within a short time. Constructivist method cannot boast of this.

2.6 Retention of Students in Algebra

Chianson, et al (2011) define retention as the ability to remember things. Kudu and Tytoo (2002) described retention as the individual's ability to hold in the mind the acquired knowledge and skills and apply same when the need arises. Furthermore, Ruhrer and Taylor (2006) state that perhaps no mental ability is more important than our capacity to learn, but the benefits of learning are lost once the material is forgotten. Such forgetting is particularly common for knowledge acquired in school, and much of this material is lost within days or weeks of learning.

Mathematics educators and researchers have pointed out that the use of conventional teaching methods by Mathematics teachers have invariably resulted in poor performance of students in teacher-made tests and standardized examinations.

Research findings have shown that there is a positive relationship between integrated and single teaching strategies and students' achievement and retention in Mathematics. Sivak (2013) used a combination of teaching methods in teaching students at Green Holly Elementary School, USA. He reported that the students taught with integrated method improved significantly more than those taught with single method. Similarly, Schofield (2004) cited in Anyor (2014) reported that by combining basic skill instruction, discovery learning and conceptual learning, he recorded a significant improvement in achievement and retention among students taught with combined strategies than those taught with single strategy.

Still on appropriate teaching strategies, Rohrer and Taylor (2006) state that the identification of learning strategies that extend retention would prove beneficial to students and any others who wish to retain information for meaningfully long period of time. Therefore, they carried out two experiments that examined how the retention of a moderately abstract Mathematics procedure was affected by variations in either the total amount of practice or the scheduling of this practice. Specifically, the two learning strategies are known as over learning and distributed practice. By an over learning strategy, a student first masters a skill and then immediately continues to practice the same skill. Distributed practice on the other hand, requires that a given amount of practice be divided across multiple sessions and not massed into just one session. They came out with the conclusion that the retention of Mathematics is markedly improved when a given number of practice problems relating to a topic are distributed across multiple assignments and not massed into one assignment. Therefore, any resulting boost in students' Mathematics retention might greatly improve the Mathematics achievement (Rohrer & Taylor, 2006).

In a separate studies conducted by Kajuru and Isah (2014), it was reported that constructivist learning strategy enhances significant improvement among students' performance and retention of Mathematics. This study also showed that as a result of students' interaction in the group, students were able to create a new learning experience for themselves. Therefore, it is important for Mathematics teachers to use a combination of teaching strategies as this has the potency of enhancing students' retention and performance in Mathematics.

Besides, there seem to be a connection between class size, and performance and retention. Lopus and Maxwell (1995) revealed form their research that there are advantages of small class size against the demerits of large class size and even went beyond academics to such areas as students' retention. Some of the consequences of the large class size syndrome on students include; truancy, poor attitude to learning, limitation to individual activities, self-indulgence, examination malpractice, cultism and a host of others.

Efe (2005) corroborated this stating that increasing class size has a negative effect on students' performance. The study further shows that small class size promotes elaboration. Elaboration provided from one student to another is a win-win situation. It not only enhances the learning of students who receive the explanation but also deepens the understanding of students providing the explanation of a topic which brings complete retention of a topic being learnt for a longer period.

2.7 Attitudes of Students towards Algebra

Attitude is an organization of beliefs, feelings and behavioural tendencies towards an object (Vaughang, 2005). Ado (2014) defined attitude as a mental or neutral state of readiness, organised through experience, exerting a directive and dynamic influence upon the individual's response to all objects or situation with which it is related. Furthermore, Salman, et al., (2012) described attitude as effective by-product of an individual's experiences. That is to say, attitudes results from personal desires and group stimulation. Thus attitudes are the products of related beliefs and values.

Attitude can also be explained to mean the determining tendencies which affect people decisions, actions, and opinions. Therefore, attitude could be positive or negative. Southwell and Perry (2006) assert that attitudes are generally regarded as having been learnt. They predispose an individual to action that has some degree of consistency and can be evaluated as either positive or negative. it is characterized as learnt implicit response that varies in intensity and tends to guide an individual's responses to an object. Similarly, Marianne and Elame (2005) affirmed that attitudes are positive or negative views about a person, object, idea, or situation which influences individual choice of action and responses to challenges. Yet, Mensah, et al., (2013) stated that attitudes are psychological orientations developed as a result of one's experience which influences a person's view of situations, objects, people and how to respond to them either positively or negatively or favourably or unfavourably.

There is considerable evidence from research on attitudes and their relationship with education which shows that attitude of a child is often a satisfactory prediction of his/her performance in school (Mukherejee, 1978 as cited in Ahmed, 2019). For instance, Furinghetti & Pekhonen (2000) state that the learning outcome of students is strongly related to their beliefs and attitude towards Mathematics. Closely related to attitude is interest of students to Mathematics and performance. Uhumuavbi & Umoru

(2005) reported that the relationship between interest in Mathematics and achievement in Mathematics and science among Polytechnic students of Auchi Polytechnic found that at polytechnic level, intrinsic and extrinsic interest in Mathematics are important determinants for achievement in Mathematics and success.

Attitude towards Mathematics plays a crucial role in the teaching and learning of Mathematics. Review of literatures depicts varying opinions and findings on students, attitude towards science and Mathematics and their performances. Yawa (2009) in comparative study of factors influencing Mathematics achievement found that there is direct link between student's attitude towards Mathematics and student's outcomes. This is equally buttressed by Mensah, et al., (2013) saying that most researches on attitude points to the fact that attitude plays a crucial role in learning and achievement in Mathematics hence determines the student success in the subject. It determines their ability and willingness to learn the subject, work on a variety of assigned task available. In many cases, students have been found to view Mathematics as procedural and rule-oriented. This prevents them from experiencing the richness of Mathematics and the many approaches that could be used to develop competence in the subject. Yet, Ma and Xu (2004) referred to the students' attitude towards Mathematics as the best predictor of Mathematics achievement.

Researchers concluded that positive attitude towards Mathematics leads students towards success in Mathematics. Nicolaidu and Philippou (2003) asserted that when students have positive attitudes towards Mathematics, they would achieve better which reflect a significant relationship between attitudes and performance. Mensah (2013) went further to state that positive reinforcement creates room for the formation of positive attitude for Mathematics. According to him, attitude towards Mathematics has a more complex scenario characterized by the emotions that one associates with Mathematics, one's beliefs about Mathematics and how one behaves towards Mathematics. This attitude, if negative, is reflected by the fact that students ma shy away and would always try to avoid Mathematics tasks.

Most of the researches done tried to establish the relationship between students' attitudes towards Mathematics and academic achievement. However, Fraser and Kahle (2007) as cited in Mato and De La Torre (2010), showed that learning environments at home, at school and with peer group accounted for a significant amount of variance in student attitudes, showed that high achievement could serve to predict a positive attitude towards Mathematics. But such an attitude could not predict stronger achievement. Bolaji (2005) and Yawa (2009) explored that teacher's attitude is one of the major factors affecting students' learning. Maria (2012) when reviewing literature aimed at understanding attitudes and influences on their development identified three groups of factors that play vital role in influencing students' attitudes. These include: factors associated with students themselves, such as: Mathematics achievement, anxiety, self-efficacy, self-concept, motivation and school experiences; factors associated with the school including the teacher and teaching materials, classroom management, teachers' knowledge, attitude towards Mathematics, beliefs and motivation; factors from home environment and society including educational background, parental expectations and occupation of the parents. With this wide range of variables influencing attitudes, this research would therefore consider a few of these variables (student individual factors) with a view of providing in-depth understanding of those factors. These include mathematical achievement, mathematical ability, general beliefs and perception about Mathematics.

2.8 Comparison between Discovery Learning Approach and Lecture Method of Teaching

Opportunities for discovery activity occur whenever inadequacy of knowledge (of concepts and/or skills) produces a situation where students don't know "what to do next" so they must think on their own, and are allowed to think

These opportunities for discovery can be accidental (when a teacher does not realize that students are struggling) or the obstacles can be intentional, designed into a lab as thinking activities that let students practice existing skills or learn new skills. If a particular lab has a sufficient amount of discovery activities compared with other types of thinking activities, so the ratio of discovery/non-discovery is high, it can be called an discovery lab. A well-designed discovery lab, like a well-written mystery story, aims for a level of challenge that is "just right" so students will not become bored with problems that are too easy, or become frustrated because the problems they encounter are too difficult and frequent. Ideally, students will struggle temporarily but eventually they will succeed, and in doing so they will feel genuine emotional-and-intellectual satisfaction. They will place a high personal value on their own success because they were able to overcome challenging obstacles during the process of problem solving.

Forms of Discovery Learning

Dr. Roger Schank and Chip Cleary (1994) have proposed five main Discoveries for categorizing the Discoveries for discovery learning.

- incidental learning,
- learning by exploring/conversing,
- learning by reflection,
- Simulation-based learning. By utilizing these Discoveries, teachers can build activities to allow their students to discover the desired concepts.
- Incidental Learning

Incidental learning is probably the most entertaining form of discovery learning. In incidental learning, students gain knowledge "in passing" (Schank & Cleary, 1994; Bicknell-Holmes & Hoffman, 2000). Learning is a by-product of an incidental learning task in which the students are engaged. My experience has been that students typically love participating in incidental learning because many times the task takes the form of a game. Incidental learning activities work well with dull topics and rote memorization because they provides motivation to learn topics or skills that are typically perceived by students as not very interesting but are in the curriculum. Two examples of incidental learning would be to have a classroom game show or to make a crossword puzzle on the desired topic. Incidental learning, because of its game-like quality, can be motivational to students. Students often become interested in the topic of study and look for answers because they want to do the activity and must have the knowledge to do it. Many incidental activities are also suited to students being involved in the creation process; hence, additional discovery opportunities result.

2.8.1 Learning by Exploring/Conversing

Learning by exploring is also known as learning by conversing. This type of discovery learning is based on an organized collection of answers to questions individuals can ask about a particular topic or skill (Schank & Cleary, 1994). The learning by exploring method is much like the Socratic method of questioning, answering, and questioning more. Students are given a mystery to solve and they can only solve it by asking questions. In this Discovery, curiosity is intended to serve as a dramatic motivational tool. An example of the learning by exploring Discovery is playing "What's in the bag?" (Bicknell-Holmes & Hoffman, 2000). In this game, a bag containing an item is placed where it is visible. The object in the bag should reflect the desired topic for learning, for example, an elephant when studying animals. The students then ask questions to figure out what is in the bag. The students' mesh their past experiences and learning and the answers given to formulate new questions to solve the mystery of what is in the bag. For example, in the case of the elephant in the bag, students may begin by asking if the object is living. When they receive the response that it is living, the students then begin to think of all the things they know that are alive and how the next question can narrow down the field. This process allows the students to not only learn that an elephant is an animal, but also discover new ways that the information they know about animals can be categorized.

2.8.2 Learning by Reflection

In learning by reflection, students learn to apply higher-level cognitive skills by using an interrogative approach and reflecting on what they know in comparison to the qualities they are examining (Schank & Cleary, 1994). Learning by reflection allows the student to learn to ask better questions (Bicknell-Holmes & Hoffman, 2000). By learning to ask better questions, the students learn to do more sophisticated analyses (Bicknell-Holmes & Hoffman, 2000). A teacher who employs the learning by reflection

Discovery typically answers questions with more questions to model how to better ask questions so that answers can be found.

As you can see in this dialogue, the teacher does not answer the student's question directly. Instead, the teacher leads the student through reflecting on what he or she already knows and then guides the student in finding the answer.

Students not familiar with discovery learning find learning by reflection exasperating until they become better at the skill of asking good questions (Schank & Cleary, 1994). Learning by reflection requires a great deal of patience on the part of the teacher also because the purpose of this Discovery is to discover better lines of questioning and reflect on previous knowledge (Schank & Cleary, 1994). Teachers must watch as students struggle and follow errant lines of questioning when seeking an answer. The students must make the mistakes and learn from them in order for their ability to ask sophisticated questions to develop so that they might better reflect on topics.

2.8.3 Simulation-based Learning

Simulation-based learning is essentially role-playing. Students are given an artificial environment that allows for the opportunity to develop and practice a complex set of skills or witness the application of abstract concepts (Bicknell-Holmes & Hoffman, 2000). The benefit of students learning in a simulation rather than a real life situation is that time and or the natural environment can be manipulated to guide discovery (Bicknell-Holmes & Hoffman, 2000). Also, students do not have to worry about the impact of failing in a simulation. For example, in a simulation where students are learning about adaptations of animals, students can put an elephant on the top of a mountain and see what happens without having to worry about a real elephant being harmed by their mistake in thinking that is where elephants live. Simulations also allow for things to occur that would be impossible in real life. For example, students could plan a space mission and actually take the mission through a simulation, whereas, taking an actual space mission would be impossible.

Technology has played a major role in making simulations easier to incorporate into the classroom. Computers allow for variability in more components of the simulation environment by taking the burden of manually manipulating data. Through technology, simulations can be much more realistic and authentic than without the use of the technology. Technology has provided a great advantage in implementing this Discovery (Bicknell-Holmes & Hoffman, 2000).

2.8.4 Lecture Method

A lecture is an oral presentation of information by the instructor. It is the method of relaying factual information which includes principles, concepts, ideas and all theoretical knowledge about a given topic. In a lecture the instructor tells, explains, describes or relates whatever information the trainees are required to learn through listening and understanding. It is therefore teacher-centred. The instructor is very active, doing all the talking. Trainees on the other hand are very inactive, doing all the listening. Despite the popularity of lectures, the lack of active involvement of trainees limits its usefulness as a method of instruction.

The lecture method of instruction is recommended for trainees with very little knowledge or limited background knowledge on the topic. It is also useful for presenting an organised body of new information to the learner. To be effective in promoting learning, the lecture must involve some discussions and, question and answer period to allow trainees to be involved actively.

2.8.5 Preparation and delivery of a lecture

As stated earlier, during the lecture, the trainees merely listen to the instructor. It is therefore very important to consider the attention span of trainees when preparing a lecture. The attention span is the period of time during which the trainees are able to pay full attention to what the instructor is talking about. It is estimated to be 15-25 minutes only. It is difficult to hold the trainees attention for a long period of time and careful preparation of lectures is very necessary.

The instructor should have a clear, logical plan of presentation. He/she should work out the essentials of the topic, organise them according to priorities and logical connections, and establish relationships between the various items. Careful organisation of content helps the trainees to structure and hence, to store or remember it. When developing a theme in a lecture, the instructor should use a variety of approaches. A useful principle in any instruction is to go from the known to unknown; from simple to complex or from parts to a whole. Knowing the trainees and addressing their needs and interests is very important. For example, in explaining technical processes the instructor should search for illustrations that will be familiar to the trainees. Unfamiliar technical words should be introduced cautiously. New terminologies should be defined and explained and examples given.

In order to gain and focus the attention of trainees, the instructor should be adequately prepared, fluent in his/her presentation and should use various teaching aids and illustrations such as charts, transparencies, codes and even the real objects during presentation. Question and Answer periods should be included in the lecture.

2.9 Comparison between Activity-Based Teaching and Traditional Method of Teaching on Students' Achievement

In the subject of Mathematics at elementary stages, the research was experimental based on pre-test, post-test control group design. Two units of geometry were selected from seventh grade Mathematics for this research. Population of the study was the 120 students of seventh grade from GGHS Bhedian Pattoki, District Kasur, Punjab (Pakistan). Sixty students of class seventh were taken randomly from Govt. Girls High School Bhedian Pattoki, District Kasur. A pre-test was administered on them for equalizing the groups. Students were randomly divided into two groups (experimental and control) according to the results of pretest. Both tests were developed from the seventh class Mathematics book for the compilation of data. Tests were administered keeping cognitive domain in view. Selected unit 10 (exercise 10.1 to 10.4 and revision exercise) and unit 12 (12.1 to 12.6 and revision exercise) from seventh class Mathematics book prescribed by Punjab Text Book Board were taught to both groups (experimental and control) for a period of eight weeks. Activities were used for experimental group only and other group was taught traditionally. Time for the teaching Mathematics was 40 minutes daily to each group. Independent sample t-test was applied on the pre-test and post-test scores to check whether there is a difference in the performances of two groups. It was also concluded that students taught through activity based teaching performed better in post-test. It is recommended that in future Mathematics may be taught with activities at elementary level. Mathematics kit containing material for activities may be provided to Mathematics teachers. Keywords: Mathematics, geometry, traditional method of teaching, activity based teaching/learning * Ph.D Scholar, The University of Lahore, Pakistan. Email: razia.noreen@gmail.com ** Lecturer IER, University of the Punjab, Lahore. Email: majid.ier@pu.edu.pk Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 146 Introduction Mathematics is a key subject of study. Mathematics might be described as the essential science. It is that branch of science that utilizes numbers and signs. Numbers and signs are organized utilizing orderly numerical principles. It might be comprehensively defined as the science of space, time, capacity, amounts, shapes, numbers and their association with each other. It is considered that Math is hard to learn whereas it has unique ideas and is called the study of logical thinking. It assists a person to provide precise clarification to his thoughts and decisions. Mathematics is the establishment for achievement in child's instructive practice.

The nation needs such persons who would be capable to handle difficult issues and have competency to take care of various issues. They ought to have the capacity to pass on their ideas to others affectively. Education of Math furnishes the learners by such abilities and manners that are vital for the effective lifespan in a civilization. Knowledge of Mathematics creates inventiveness and unlocks the minds of the pupils. Geometry is one of the most widely used areas of knowledge. It is the key to Mathematical thinking. Geometry is a part of everyday life and different geometric shapes are part of our normal environment. Students take interest in their daily used items. Geometrical items are easily available in students' daily life. So, researcher selected this branch of Mathematics for research study. Rationale of the study The greater part of educating in classrooms is completed by traditional method generally. The kids sit silently in rows in the classrooms, the educator does all the speaking and the pupils inactively listen to the instructor. They talk just when approached and do just as they are told. In a conventional classroom, the learning abilities of majority of the learners are restricted only to duplicate what is written on the board and they are not capable of effectively handling the data through thoughts, evaluation and investigation. Because of this constrained intellectual capability, learners lose interest in learning. Activity based teaching is a strategy focused on the idea that learners ought to be included through activities. Activity based teaching is a method adopted by a teacher to emphasize his or her technique of teaching through action in which the learners take interest comprehensively and realize effective learning practices. It is the procedure in which the child is effectively included in taking interest rationally and physically. Activity-based learning is interpreted as meaningful school learning settings in which the learner creates Mathematical ideas through dynamic contribution. This procedure may include the control of physical materials, the usage of games, or participating in experimentations with physical items.

Noreen, Munir & Rana 147 Fundamentals of Mathematics are taught at basic level. Therefore, an instructor ought to instruct the essential equations and ideas with full commitment and constant work. Instructors ought to satisfy the pupils at this level and ought to response every one of their questions. Traditional method of teaching Mathematics is still utilized as a part of a large portion of the educational establishments in Pakistan. In this strategy, instructors do not use activity and AV aids in instructing except of white board. Pupils don't appreciate this technique. Utilization of activities can make the education of Mathematics further successful. Keeping this perspective in view the investigator has attempted to work on "finding effects of activity based teaching and traditional technique of teaching Mathematics at students of elementary classes". Review of the Literature Mathematics: Mathematics is language of nature and plays dynamic role in human life. Its learning is a compulsory part of curriculum from early childhood to secondary education in the entire world. According to Babar, (2011, p. 23) "Mathematics originates from nature. Mathematics started with simple counting and these numbers adopted new forms with the passage of time. New branches of mathematics came into being. Abstract ideas in mathematics helped in discovery of new formulae which made abstract ideas clear to man." Saleem (2006, p. 28) described, "Mathematics is deductive study of numbers, geometry and different dynamic constructs or structures. It is comprehensively divided into foundations, algebra, investigations and geometry which include hypothetical computer science." Mathematics is simply an extension of reality.

Pound (2011, p. 1) described, "Mathematics is the unique key which turns the lock of the physical universe." Nisar (2005, p.1) described, "Mathematics is the science that uses easy words for hard ideas." He quoted the famous saying of Muslim scholar Ibn-Khaldun, "Mathematics cleans the filth of mind as soap cleans the dirty clothes." No other subject can be alternate for Mathematics. Saleem (2006, p. 29) described, "Mathematics is considered as exercise for the brain. It develops cognitive functioning, which enhances ability to think quickly, rationally, practically and abstractly. It also improves general problem solving ability for use in all facets of life." Significance of Mathematics is confirmed mostly by its efficiency, in economics, science, and engineering and in public decision-making. Mathematics is an interesting subject and is helpful in problem solving. Anything we learn from Mathematics helps us in arts, sciences, finance and health. It is true that Mathematics helps us in each and every sphere of life. According to Singh (2004, pp.46- 47) "In our daily life it is mixed as the oxygen in the air. Every day of our life begins and ends with the Mathematical thinking. We use Mathematics in our daily household problems, food, clothing, idea of quality and quantity, daily account of income and expenditure, allocation of funds etc." Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 148 Mathematics is the queen of all sciences and this imperative subject needs effective strategies for teaching. It is viewed as that Mathematics is uninteresting subject and has theoretical ideas.

According to Amirali (2010, p.27), "Mathematics is at the sentiment of numerous effective vocations and effective lives for improvement, especially in extraordinary and quickening change circumstances. However, as a general, a great many people and pupils specially hate Math. The survey of school-based instructive research has found that the larger part of pupils discovers Math as the most tough, unique, theoretical, tiresome, destructive and tedious subject." Geometry: The concepts of Geometry affect every person from birth to death. Pictures that child draws with points, lines and planes are simply representations of abstract ideas. It provides knowledge and enables students to do things logically. Geometry has central position in the modern Mathematical applications and it plays a vital role in finance, weather forecasting or in other fields. Some Geometrical principles (e.g. equality, proportion, similarity) are implanted in the nature of things. It is useful in many other branches of study e.g., engineering, architecture, interior decoration, construction etc. According to Ahmad (2005, pp. 69-70), "Geometry is the science of space and extent. It develops the ability to draw accurate plans and is important in a person's cultural development. In ancient time, the flood of River Neel erased the sign of measurement of agricultural area. It was for this reason that the area for agriculture had to measure again for dividing among farmers. The area was measured again and again because in those days agriculture near the rivers and flood of river erased its measurement. It became the base of Geometry. Geo means land and metry means measurement. Rafiq and Ansari (2012, p. 125) described about Geometry, "Geometry has a long and wonderful history. It helped us to make art, construct buildings, development of structures and to find different universe. In this way, the learning of geometry remained the center of ancient Mathematicians." Geometry is the branch of Mathematics stressed with the properties of points, lines, surfaces and solids.

Most manufactured items follow ordinary geometric structures: book is rectangular; a wheel is round, a sandwich is triangular etc. Geometry is in this way a unique thought that helps us to examine measure and make objects. It is greatly important, because it permits us to simplify the great complication of nature. Geometry is one of mankind's most powerful thinking instruments. In the words of Kausar and Zaheer (2008, p.19) "Geometry signifies "land estimation." Geometric thoughts were produced by early man when he watched and looked at changed shapes in his surroundings environment and when he was met with the issue of measuring land." The place of Geometry in the school educational programs is very significant. Geometry has central position in the advanced Mathematical applications and it plays a dynamic role in finance, weather forecasting or in other fields. Noreen, Munir & Rana 149 Traditional Method of teaching: In Traditional Method of teaching the instructor is viewed as the pivot in the classroom, responsible for all actions and guaranteeing that all class room message goes through him or the deductive strategy for instructing. Conventional technique is content focus. In this, instructor remains more dynamic, more subjective and less affective (Singh (2004).Conventional techniques are concerned with the review of true information and mainly disregard higher levels of rational outcomes (Rao, 2001). Traditional teaching strategy works against the normal working of human mind (Weber, 2006). Students are involved in repetitive learning. Instructor forces the students to repeat the material that has been told to them. Corporal punishment, hatred of the teachers and frightening role of commanding teacher is noticeable generally in our classrooms.

During the long conventional teaching periods, interests and consideration of learners can't be looked after (Cangelosi, 2003). Conventional strategy is an instructor focused technique. In the conventional technique, a lot of tension is laid on the educating of course book by utilizing the technique, which is alike, an adjustment of the Grammar-interpretation strategy. Traditional teaching strategies are defined as being teacher-arranged, in a speech style and are firm. Lessons are typically educated by the teacher presenting skills utilizing a blackboard joined by a verbal clarification or lecture. According to reformers, traditional instructor-centered techniques concentrated on repetition learning. Traditional teaching strategies tend greatly toward class address book knowledge through repetition and retention of actualities, equivalences and formulas. Recitation as a general rule comprises repeating without tending what the book or teacher has communicated. "The teachers are ignorant of the current investigations in the field of dialect educating. The part of instructor inside the class is dictator with the minimum contribution of the learners." (Behlol, 2009, pp.2-3). The traditional teaching technique comprises primarily conveying addresses by the instructors and pupils are mentally dynamic, however, physically sit without moving. Learners might be involved in note taking (Haghighi, et al., 2005). In classroom teaching learning sessions, the main physical task done by the students is either note-taking or remaining on the seat to answer any inquiry of the teacher. There is no way for learners to present somewhat in the class to talk in the class and thus pupils get to be inactive learners. It makes the entire procedure of the showing learning dull and dry. It provides no room in any movement to the educator and to the learners. The learners think about the dialect yet they are not in situation to talk easily. A disadvantage of this technique is that students who have learning problems can't adjust how the lessons are conveyed.

Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 150 Activity-based Teaching/Learning: Learning by doing is very important in successful knowledge because it is proved that more the senses are inspired, more a person learns and longer he/she retains. Activities bring activeness and smartness among the learners. Because we know that education means all round improvement of the child, therefore we have to organize numerous activities to build up the learner's personalities in several ways. Activity-based instruction technique acts as a dynamic problem solver for the learners. It improves innovative part of experience and gives reality for learning. It gives various experiences to the learners to encourage the acquisition of information, experience, abilities and qualities. It builds the students self-confidence and creates understanding through works. It creates cheerful relationship and enthusiasm for them. If child is given the chance to investigate by his own and gave an ideal learning environment, then the learning gets to be cheerful and durable. It inspires the learners to apply their innovative ideas, information and minds in solving problems. Under Activity-based learning instruction key focus is on child or we can state that it is one of child focused approach. It creates self-learning ability among the students and allows a student to learn according to his or her ability. As noted in Johnson, et al., (1998) (referred in Ahlfeldt, Mehta, & Sellnow, 2005, p.52), "It is the old pattern to give all the resources to the inactive learner by the teacher. The innovative pattern is to dynamically connect learners with the resources and each other."

According to Hussain, et al., (2011), Activity-based learning integrated with peer instruction creates an ideal situation for teaching science subjects and specially physics. In an activity-based learning class, students are actively involved in hands-on experiences and get chance to relate abstract ideas and theories with concrete observations. This helps them to make deep understanding of scientific concepts. Çelik (2018) describes, It was seen that activity based learning activities improve students' academic achievements and attitudes towards activities. According to Shah and Rahat (2014), Activity-based learning teaching method generates an ideal situation for science teaching especially at Elementary level. In activity-based teaching methods, learners are involved actively in hands-on minds on experiences and acquire an opportunity to relate intangible concepts and theories with actual observations. Activity based teaching method helps learners to understand the scientific concepts. Students' actively involved in teaching learning process and activities help them in application of scientific knowledge in various real life situations. "Activity based mathematics instruction is based on activity by involving learners in reading, discussion, practical activities, engagement in solving problems, analysis, synthesis and evaluation (Festus, 2013)." Innovative teaching methods that provide positive mathematical learning experiences could help to enhance students' achievement in mathematics (Riley et al., 2017). If the learner is provided with the opportunity to explore their environment and provided an optimum learning Noreen, Munir & Rana 151 environment then the learning becomes joyful and long lasting. This learning strategy means reversing the traditional teacher-centered understanding of the learning process and putting students at the center of the learning process (Golji & Dangpe, 2016).

As per Fallows and Ahmet (1999), "education is best when learners' association, contribution and collaboration are maximized." McGrath and MacEwan (2011) clarified, "In activity-based instruction, the learner participates in the educational procedure during demonstration of 'doing' than in conventional technique."According to Prince (2004), "Activity-based learning is a learning technique where learners are busy in the educating process." Activities related to actual life practice help out students to exchange information into their individual information which they can relate in diverse conditions. (Edward, 2001). Kenly (2007, p.57) stated, "activity-based learning technique is diverse from conventional technique of instructing. Learners take active part in it. Activity-based learning is such education in which learner is dynamically involved in doing or in considering something prepared. As Churchill (2003) said, "such learning helps learners to make intellectual models that take into consideration 'higher-order' presentation, for example, applied critical thinking and exchange of data a skill". According to Hake (1998) "learners' inspiration by interfacing with learners in instinctive activities is a feasible and useful technique for instructing difficult ideas.

He described the significance of various activities correlated to the thoughts being displayed." Learners' inspiration is high if these activities are face-to-face to the learners (Hug, Krajcik & Marx 2005). In lab strategy learning by doing may be possible as in activity based teaching/learning. Objectives of the Study Following were objectives: 1. To analyze the students' achievement taught through activity based teaching and the traditional method of teaching Mathematics. 2. To check the retention power of students taught through activity based teaching. Research Hypothesis Following were hypotheses: 1. There is no important differentiation in mean achievement scores of students instructed by activity-based teaching and the conventional technique of teaching in Mathematics at elementary school students. 2. There is no important differentiation in mean score on retention power of Mathematics learners instructed through activity based teaching at elementary level. Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 152 Delimitations of the Study: Govt. Girls High School Bhedian (Pattoki) District Kasur was selected for research study. Only students of seventh class were included. Academic Session for research study was 2016-17. (Fundamentals of Geometry 10.1 to 10.4 and revision exercise) and (Circumference, Area and Volume 12.1 to 12.6 and revision exercise) were selected from the subject of Mathematics for research study. Research Methodology Population of the Study: All (120) student of class seventh from Govt. Girls High School Bhedian Pattoki District Kasur constituted the population.

Sample of the Study: For selection of sample 60 students of class seventh were taken randomly from Govt. Girls High School Bhedian Pattoki District Kasur. A pre-test was administered for assigning the pupils to two groups (experimental and control) on the basis of outcome comparing equal marks. Content of the Study: (Fundamentals of Geometry 10.1 to 10.4 and revision exercise) and (Circumference, Area and Volume 12.1 to 12.6 and revision exercise) were selected to teach to both groups. Research Design: The research was experimental based on pre-test, post-test control group design. Procedure of Data Collection Pre-test and post-test were made from (Fundamentals of Geometry 10.1 to 10.4 and revision exercise) and (Circumference, Area and Volume 12.1 to 12.6 and revision exercise) of seventh grade Mathematics. Out of 50 questions, ten (10) of knowledge, ten (10) of comprehension, ten (10) of application, ten (10) of analysis, and ten (10) questions of synthesis were made. The circulation of the questions keeps on same for every domain in the pre-test and post-test. 25 MCQs items were included in pre-test and 25 MCQs items were included in post-test. Different items were used for pre-test and post-test which were selected from same content so that effectiveness of activity-based teaching would be checked in better way. All items were selected keeping in view cognitive domains. Proportion of items according to cognitive domains was same in pre-test and post-test. Items of all levels (knowledge to synthesis) were included in tests because students learn more effectively if easy to difficult and concrete to abstract way would be used.

Noreen, Munir & Rana 153 On the result of the pre-test two equal groups were formed experimental group and control group. Result list was prepared in descending order. First student was in Group A, second in Group B, third in Group A, fourth in

Group B and so on. Mean of both the groups were same in the start. Pre-test was administered to the seventh class before the start of the experiment. (Fundamentals of Geometry, Circumference, Area and Volume) were taught to both groups (experimental and control) for the time of two months. Experimental group was taught with activities and other group was taught without it. Different activities were selected according to the units selected from seventh class Mathematics to teach experimental group while the control group was taught without using these activities.

Activities as for example students pointed out line segment, lines, parallel lines, rays & angles, acute, right and obtuse, complementary and supplementary angles, adjacent and vertical angles, triangles, congruent and similar figures, circle, radius, diameter and chord, arcs, semicircle and segments of circle, from their classroom, from different books, papers, work sheets, pictures, from cards and other things (candle, matchbox stick, torch and bulb) put in basket. Student drew these shapes on white board, note books, charts, graph paper and gave different names to different things etc. Students made all these shapes by scissor, glue stick, different small boxes and formic sheet, thermopile sheet, pins thumb pins. Students gave examples of these shapes with straw, ice-cream sticks, with their arms, book, note-book, geometry-box, charts, calendar, shawl, candle, match-box stick, torch, bulb, scales, scissor, clocks, color shawls, currency note, glass, torch, window, door, wall, board, the Sun, the full Moon, wheels of cars, clocks and watches, dinner plates, (pizza, wheel, plate, mirror, football, biscuit, and bottle, lid of bottle, sharpener, bangle, fan, button, and plastic pins) working fan, dry milk box for cylinder etc. Students made different geometrical shapes physically as angles with their arms, fingers and elbow etc. It was guessed about different shapes who am i? Students competed with others in making different geometrical shapes, writing different angles on board and in note-books. Students measured different geometrical objects with protractor, scale and so on. Selected content of Mathematics was taught to each group daily for 40 minutes. On completion of teaching of the specified units with activities and without activities a post-test was prepared in which items were selected from all levels in order to determine the effectiveness of treatment.

Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 154 Analysis and Interpretation of the data Mean score and t-test were used to evaluate and analyze the test marks of two groups. Independent sample t-tests at .05 level of significant were applied on both the tests scores to check whether there is really important distinction between the performance of two groups previously, and afterward the treatment. Mean value, standard deviation, t-value and p-value were calculated for the purpose of data analysis. Comparison of the performance of pre-test of both groups Groups N M SD t-value df Significance/P-value Experimental Group 30 18.47 4.125 .000 58 1.000 Control Group 30 18.47 4.091 Table value of "t" at 0.05 = 2.00 It shows that the mean score of pre-test of experimental group is 18.47 with SD 4.125, and the mean score of pre-test of control group is 18.47 with SD of 4.091. The tabulated-value for df 58 is 0.000 whereas table value is 2.00. As calculation of t is less than table value. Therefore, it may be concluded that results of both groups were the similar before the treatment. Comparison of the performance of post-test of both groups Groups N M SD t-value df Sig/P-value Experimental Group 30 48.80 2.140 33.876 58 P < .001 Control Group 30 20.00 4.136 The mean score of post-test of experimental group is 48.80 with

SD of 2.140 and the mean score of post-test of control group is 20.00 with SD of 4.136. The computed tvalue for df 58 is 33.876 whereas table value 2.00 which is not as much as table value. As computed t-value is greater than table value so H0 (There is no important differentiation in students' mean achievement marks instructed by activity based teaching and the traditional teaching method in Mathematics at elementary school level) is rejected and alternative hypothesis, H1 (There is important differentiation in mean achievement marks of learners instructed by activity based teaching and the traditional teaching method in Mathematics at elementary school level) is accepted. Therefore, it may be concluded that results of both groups were the different in post-test. Achievement scores of experimental group in pre and post-test Groups N M SD t-value df Sig/P-value Post-test Experimental Group 30 48.80 2.140 37.786 29 P < .001 Pre-test Experimental Group 30 18.47 4.125 Noreen, Munir & Rana 155 The mean score of post-test of experimental group is 48.80 with SD 2.140, and the mean score of pre-test of experimental group is 18.47 with SD of 4.125.

The computed t-value for df 29 is 37.768 whereas the table value is 2.05 which is less than tvalue. As calculated t-value is not as much as table value so H0 (There is no important differentiation in mean score on retention power of Mathematics students instructed through activity based teaching at elementary level) is rejected and consequently alternative hypothesis H1 (There is important differentiation in mean score on retention power of Mathematics students instructed through activity based teaching at elementary level) is accepted hence it can be concluded that students taught through activity based teaching has strong power of retention. Comparison of the performance of control group in pre and post test Groups N M SD t-value df Sig/P-value Post-test control Group 30 20.00 4.136 1.916 29 .065 Pre- test control Group 30 18.47 4.091 The mean score of post-test of control group is 20.00 with SD 4.136, and the mean score of pre-test of control group is 18.47 with SD of 4.091. The computed t-value for df 29 is 1.916 whereas the table value is 2.05 which is not as much as t-value at 0.05 level of significance. As computed t-value is not greater than table value so H0 (There is no important differentiation in mean score on retention power of Mathematics students instructed through traditional method of teaching at elementary level)is accepted and alternative hypothesis H1 (There is significant difference in mean score on retention power of Mathematics students instructed through traditional technique of teaching at elementary level) is not accepted, hence it can be concluded that students taught through traditional method of teaching have almost same power of retention in pre-test and post-test. Discussion The results of this study are supported by the findings as noted by Hussain, Anwar and Majoka (2011) Activity-based learning integrated with peer instruction creates an ideal situation for teaching science subjects and specially physics.

In an activity-based learning class, students are actively involved in hands-on experiences and get chance to relate abstract ideas and theories with concrete observations. This helps them to make deep understanding of scientific concepts. Çelik (2018) describes, It was seen that activity based learning activities improve students' academic achievements and attitudes towards activities. According to Shah and Rahat (2014), Activity-based learning teaching method generates an ideal situation for science teaching especially at Elementary level. In activity-based teaching methods, learners are involved actively in hands-on minds experiences and acquire an opportunity to relate intangible concepts and theories with Activity-Based Teaching versus TM of Teaching in Mathematics at Elementary Level 156 actual observations. Activity based teaching method helps learners to understand the scientific concepts. Students' actively involved in teaching learning process and activities help them in application of scientific knowledge in various real life situations. "In activity-based instruction, the learner participates in the educational procedure during demonstration of 'doing' than in conventional technique (McGrath & MacEwan 2011)." "Activity-based learning is a learning technique where learners are busy in the educating process (Prince, 2004)." Activities related to actual life practice help out students to exchange information into their individual information which they can relate in diverse conditions (Edward, 2001). Kenly (2007, p.57) said, "activity-based learning technique is diverse from conventional technique of instructing. Learners take active part in it. Activity-based learning is such education in which learner is dynamically involved in doing or in considering something prepared. "Such learning helps learners to make intellectual models that take into consideration 'higher-order' presentation, for example, applied critical thinking and exchange of data a skill (Churchill, 2003)." Conclusions The results of this study did not support the hypothesis that there is no significant difference between student's achievement when taught with activity-based teaching and traditional method of teaching. It was concluded that there was no statistically difference between the mean scores of experimental and control groups in pre-test (before the treatment).

The main aim of study was to compare the effects of activity based teaching and traditional Method teaching in Mathematics at elementary level. There was significant difference between the mean achievement score of experimental and control group in post-test. Students of experimental group got higher marks

2.10 Problem Solving Technique Versus Lecture Method

Using a problem solving approach to teaching and learning mathematics is of value to all students and especially to those who are high achieving. Some of the reasons for using problem solving are summarized below.

Problem solving places the focus on the student making sense of mathematical ideas. When solving problems students are exploring the mathematics within a problem context rather than as an abstract.

Problem solving encourages students to believe in their ability to think mathematically. They will see that they can apply the maths that they are learning to find the solution to a problem.

Problem solving provides ongoing assessment information that can help teachers make instructional decisions. The discussions and recording involved in problem solving provide a rich source of information about students' mathematical knowledge and understanding.

Good problem solving activities provide an entry point that allows all students to be working on the same problem. The open-ended nature of problem solving allows high achieving students to extend the ideas involved to challenge their greater knowledge and understanding.

Problem solving develops mathematical power. It gives students the tools to apply their mathematical knowledge to solve hypothetical and real world problems.

Problem solving is enjoyable. It allows students to work at their own pace and make decisions about the way they explore the problem. Because the focus is not limited to a specific answer students at different ability levels can experience both challenges and successes on the same problem.

Problem solving better represents the nature of mathematics. Research mathematicians apply this exact approach in their work on a daily basis.

Once students understand a problem solving approach to mathematics, a single well framed mathematical problem provides the potential for an extended period of exploration, comprehension and learning of the subject while always keeping track of the student's progress. The tutor also participates in the process of problem-solving based learning as a co-learner. This style of teaching and engaging with the student allows for a tutor to gain access to the students learning style and evaluate the performance overall.

2.11 The Benefits of Problem solving for Students

2.11.1. A Student-Centered Approach

Real life problems vastly extend outside the average curriculum. To prepare the leaders of tomorrow, problem-solving based learning is a student-centered model involving students within their own progress, and integrating their interests and abilities into the education. CTL Tutoring believes in this method and encourages students to make choices, trust their abilities, and to consider what learning style works best for them. In the end, our goal is to drive students towards a future they will excel in, therefore we're equipping them with tools needed for lifelong success.

2.11.2 Developing Lifelong Skills

Problem-solving based learning – especially in terms of STEAM (science, technology, engineering, art, and math) education – strengthens key factors in a student's development. Our tutors measure progress based on the student's ability to be faced with a problem and react by asking questions, connecting the dots, applying critical thinking and developing a solution.

In order to get there, we're promoting engagement and collaboration, improving leadership instincts, developing positive organizational habits, and providing a mental and emotional boost along the way. By taking this approach, CTL students develop the groundwork from an early age and take these transferrable skills required to succeed in post-secondary and in the field with them.

2.11.3. Promoting Lifelong Learning

By integrating problem-solving based learning in tandem with K-12 curriculums, students are becoming conditioned to approach life with open minds year over year. This mindset and ability to recall information will benefit the student for both in-school test taking and out of school problem-solving.

Open dialogue is welcomed by CTL Tutoring, so students have the chance to share their opinions and answer questions. With this engagement, they learn new ways to identify the various prospects of a point and rebuttle with their own knowledable response. This method of problem-solving based learning increases participation of each candidate in discussion and will lead to more student involvement. These are skills students will take with them from their CTL tutoring sessions and be able to utilize the rest of their lives.

2.12 Overview of Related Studies

This section gives the overview of similar studies as they relate to the present research work as follows:

In a study on student's performance in Mathematics, Kim (2005) sought to find what effect constructivist teaching would have on the academic performance of students in Korea. The study included a total of 76, 6th grade students, divided into two groups; experimental group and a control group. The performance of students was observed for forty hours over nine weeks period. The students were tested on the mathematical skills in counting, calculating area, volume, ratio and proportions. Both groups were given pre-test then received instruction in the constructivist or traditional teachings, and then given a post-test. The test results were analyzed using a Cronbachs Alpha (range 0.74 to 0.81). The test – retest correlation coefficient ranges from 0.85 to 0.93. Kim concluded that in the overall academic performance, there was a significant difference in academic performance with the students who learned Mathematics constructively performed better than the traditional instructed group. Besides, the researcher concluded that students preferred constructivist Mathematics teaching. However, the present study differs slightly form Kim (2005) by forming four groups, and adding more variables in the study such as retention and attitude.

Usman and Ebuta (2006) carried out a study entitled "Enhancement of Students' Achievement in Geometry Using Problem-Solving Models". Experimental research design was used with the sample size of 214 SS1 students. Geometry Achievement Test (GAT) was employed for data collection and the statistical tool used was Analysis of Covariance (ANCOVA) at P = 0.05. The study reveals that there was no significant difference between experimental and control groups. However, the present study differs from Usman and Ebuta (2005) by adding other variables in the study such as retention, attitude, activity-based, and guided-discovery teaching strategies.

In another study, Dogru and Kalender (2007) compared science classrooms using traditional teacher-centred approaches to the using of student-centred constructivist methods with 140 students. In their initial t-test of students performance immediately following the lessons, they found no significance between traditional and constructivist methods. However, in the follow-up assessment 15 days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods.

Akusoba and Okeke (2009) investigated the effect of activity-centred teaching approach using low cost learning kits in facilitating students' achievement and interest in Mathematics. The study was quasi-experimental with the sample of 162 students. The instrument used include: Mathematics Achievement Test (MAT) and Mathematics Interest Scale questionnaire (MIS) for data collection. in analysis, mean score, and standard deviation were used to answer questions, while Analysis of Covariance (ANCOVA) was used to test the null hypothesis at 0.05 level of significance. The result showed that significant difference exist between the experimental and the control groups. Adaptation of activity-centred approach using low cost learning kits as an alternative to conventional method would improve higher achievements and interest in Mathematics. However, the study did not target a particular area of Mathematics where students were found to have difficulties. Therefore, this present study will focus on constructivist strategies for teaching and learning to facilitate students' learning of Algebra in particular, and Mathematics in general.

Emaikwu (2012) worked on assessing effectiveness of three teaching methods in the measurement of students' achievement in Mathematics in Ogbadibo Local Government Area of Benue State, Nigeria. The design used for the study was pre-test and post-test quasi – experimental design. 150 students sampled from three secondary schools were used for the study. The instrument used for data collection was a 30-item cognitive achievement test in Mathematics (CATM) developed by the researcher. The major hypothesis of the research is that; there was no significant difference in the mean achievement scores of the students taught Mathematics using activity, discussion and lecture methods. The result of the major hypothesis indicated that there was significant difference in the mean scores of the students taught Mathematics using activity, discussion and lecture methods in favour of activity method, followed by discussion method and lecture method had the least. Since he used activity method as one of its variables, this can be a reference to the present study.

Adamu (2014) studied the effect of problem-solving instructional strategy on self-efficacy and creativity and academic achievement on genetics at N.C.E. level in North-West Nigeria. The researcher used experimental design, 100 students sampled were used in Genetic Achievement Test (GAT) as the instrument for data collection. The researcher used t-test for statistical at P = 0.05. He found that there was significant difference on student performance when exposed to problem-solving on self-efficacy in favour of experimental group, than those of lecture method. The present study replicated the approach to ascertain its applicability to Mathematics (algebra) so as to establish the effects of peer-tutoring to general performance of students, in particular the slow learners.

Almost every literature under review focuses mostly on lecture method and only one of the methods of the constructivist for students' academic achievement. Therefore, this study thus conceived to fill the gap in investigating lecture method and all constructivist methods (problem-solving, activity, and guided-discovery) on students' academic performance, retention, and attitude towards Algebra in particular, and Mathematics in general.

2.13 Implications of Literatures Reviewed on the Present Study

The literature reviewed showed the results obtained from several research studies in the three constructivists' strategies and lecture method for teaching/learning Mathematics, especially as they affect academic achievement, retention, and attitudes of students towards the subject. All literatures reviewed agreed that there is consistence of poor performance of students in Mathematics, year in, year out, in Nigeria. This trend of non-performance was attributed to many factors ranging from socio-economic background, heredity, psychological, environment, teaching methods used by Mathematics educators.

Negligence of teaching strategies has been the worst of the contributing factors responsible for poor academic students' performance in Mathematics. It has also been reported form literature that the use of selected methods of teaching learners in enhancing academic achievements at secondary school level is below expectation, thus poor performance persist among students.

It is in the light of the above that the researcher of the present study considered if necessary and sufficient to use the three constructivists' strategies with conventional method in teaching/learning environment to help students learn Mathematics. Evidences from the review showed that using activity-based, problem-solving and guided-discovery strategies in the teaching/learning Mathematics brings about increased Mathematics achievement, retention positive attitudes change in learners.

Therefore, using the three constructivists' strategies that is activity-based, problem-solving, and guided-discovery other researchers have not utilized simultaneously with teacher-centred approach, will lead to quantum lift in Mathematics achievement, retention and positive attitudes change in students.

Regrettably, it was also revealed that majority of the secondary school teachers in Nigeria uses lecture method where learners are perceive in the process of teaching/learning. However, the literatures reviewed revealed that activity-based, problem-solving and guided-discovery strategies as identified by the constructivists played significant role in increasing retention, positive attitude and academic achievement of learners towards Mathematics. Consequently, the increase in retention and positive attitude has advantage to Mathematics learning and bring about higher academic performance. It is with this view that this study was conducted.

Based upon this background, it is hoped that the result obtained from this study might not only motivate the government in ensuring to develop capacity building of mathematics teachers, it is also anticipated that the study would be replicated in other States of Nigeria since it is difficult to generalise to other geographical areas.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter describes the method and procedure used in conducting the study. It includes the research design, population of the study, sampling technique/sample, topic selected for the study, instrumentation, validation, reliability of the instruments, item analysis, administration of the instrument, administration of the treatment, procedure for data collection and procedure for data analysis.

3.1 Research Design

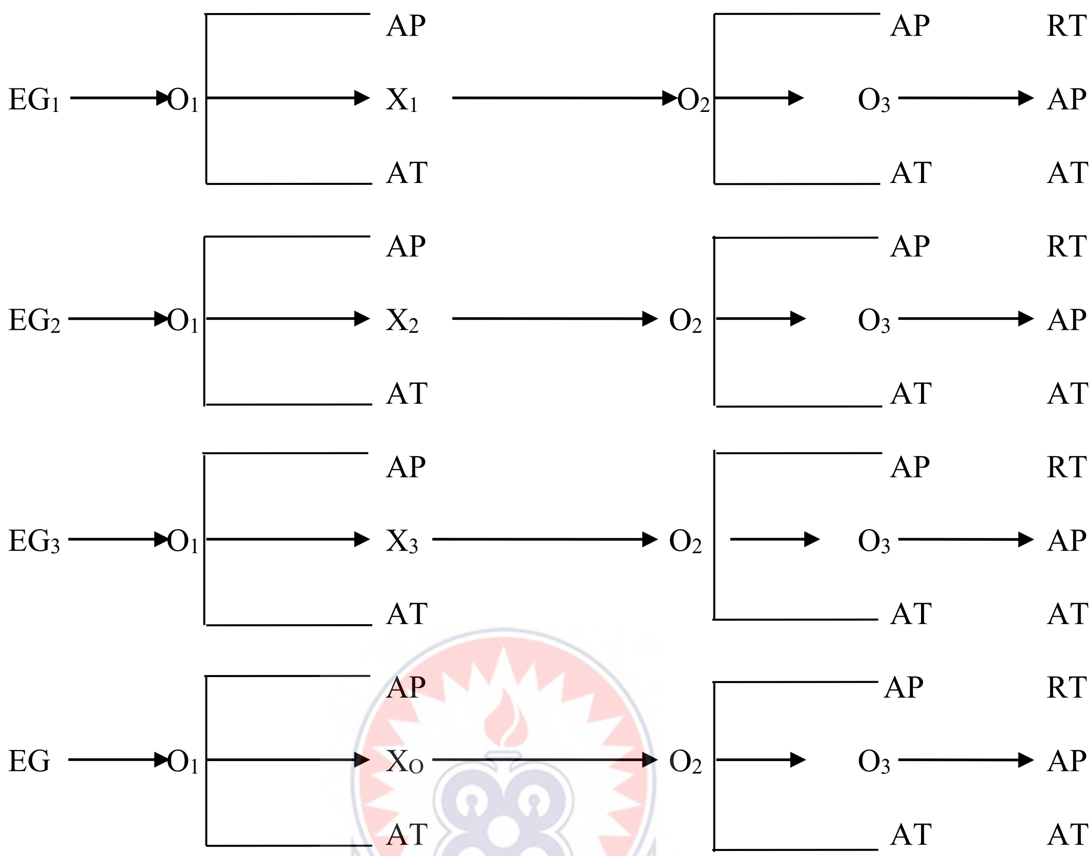
The study utilised a quasi-experimental design which adapts the pre-test, post-test, post post-test experimental and control groups design (Kerlinger, 2000 & Sambo, 2005). This is a situation where learners received the pre-test and after receiving treatment, they were subjected to the post-test and post post-test using the same materials of the instrument to check if there were any positive or negative changes.

The design contain three (3) types of Experimental Group called EG_1, EG_2, EG_3, and one (1) control group called CG; and 0_1 = pre-test, 0_2 = post-test, 0_3 = post post-test in order to determine the academic performance, retention and attitude of four groups of students. The three (3) groups in the experimental were exposed to different treatments in the teaching methodologies which were Problem-Solving (x_1), Guided-Discovery (x_2), and Activity-Based (x_3). The fourth group was the control group taught using the lecture method (x_o), in other word, called traditional teaching techniques or teacher-centred method of teaching. Both the experimental groups and the control groups were taught algebraic topics taken from the Kogi State Ministry of Education's approved Scheme of Work and the Curriculum Matching Chart for JSS II.

The four groups under study were exposed to pre-test (0_1) before the treatment for the experimental groups (EG_1), (EG_2), (EG_3); post-test (0_2). After the experimental treatment, (EG_1), (EG_2), (EG_3) and the control group (CG) were subjected to post-test and post post-test to determine the changes that occurred in terms of academic performance, retention and attitude change of students on the algebraic concepts taught using the three constructivist teaching strategies compare to conventional teaching method.

The design is presented in figure 3.1. The four schools for the actual study, one was used as a control group while the other three schools were used as experimental groups (Table 3.2). This is in line with central limit theory that recommends the sample size of ≥ 30 for any empirical research.

Figure 3.1: The Research Illustration



Source: Mukhergee (1978), Sambo and Kim (2005).

KEY:

EG_1	=	Experimental group 1
EG_2	=	Experimental group 2
EG_3	=	Experimental group 3
CG	=	Control group
X_1	=	Problem-solving strategy
X_2	=	Guided-discovery strategy
X_3	=	Activity-based strategy
X_o	=	No treatment
O_1	=	Pre-test
O_2	=	Post-test
O_3	=	Post post-test
AP	=	Academic performance
AT	=	Attitudes
RT	=	Retention

First Step:

Both the experimental group (EG_1, EG_2, EG_3) and the control group were pre-tested (O_1) in order to ascertain their homogeneity.

Second Step:

The experimental groups (EG_1, EG_2, EG_3) received treatment (X_1, X_2, X_3) respectively, while the control group (CG) received lecture method (X_o).

Third Step:

Both experimental groups and control group were subjected to post-test (0_2) in order to determine the four groups of students' academic performance at the end of five (5) weeks.

Fourth Step:

At the sixth week, both experimental groups and control group were subjected to post post-test (O_3) in order to measure retention determined by performance, and change of attitude towards algebra based on their class attendance, participation in class activities, class assignments and home work.

3.2 Population of the Study

The population of the study comprised all the public secondary school students from the three Local Government Areas of Okene, Okehi and Adavi which form the Okene Metropolis of Kogi State, Nigeria for 2020/2021 academic year with a total population of 54,490. In line with Sambo and Kim (2005), the focus is on junior secondary school (JSS II) students of these public schools. Junior secondary school (JSS I) was not to be used because they were newly introduced to algebraic concepts while junior secondary school (JSS III) are busy with the preparation for their junior secondary school certificate examination. The students were between the age of 12 and

13 years and they were males and females. They have the same average academic background.

The choice of public secondary schools for this study was because the quality of their teachers, buildings, classrooms, convenience facilities, libraries, games facilities, furniture and instructional materials were averagely similar. Furthermore, these schools use the same curriculum prepared by Nigerian Educational Research Development Council (NERDC, 2014) and approved by both Federal and States Ministries of Education. Besides, the Kogi State School Management Board supervises, funds, recruits and deployed academic and non-academic staff, supply instructional materials and all other educational facilities to these schools. The population is presented in table 3.1.

Table 3.1: Population of the study

S/N	Name of School	Type	Population
1.	FCE Demonstration Sec. Sch., Okene	Co-educational	3,520
2.	Abdul-Azeez Atta Memorial College, Okene	All boys	2,800
3.	Govt. Sec. Sch., Okene	Co-educational	2,500
4.	Okene Sec. Sch., Okene	All boys	1,750
5.	Govt. Girls Day Sec. Sch., Okene	All girls	2,350
6.	Govt. Day Sec. Sch., Irivucheba	Co-educational	2,415
7.	Lennon Memorial College, Ageva	Co-educational	2,520
8.	Ebira Muslim College, Okengwe	Co-educational	3,020
9.	College of Arabic/Islamic Studies, Okene	Co-educational	2,500
10.	Local Govt. Sec. School. Ohiana	Co-educational	2,350
11.	Okene Community Sec. Sch., Arigo	Co-educational	1,650
12.	Adavi Community Sec. School, Kuroko	Co-educational	2,810
13.	Adavi Community Sec. School, Ege	Co-educational	1,210
14.	Adavi Community Sec. School, Adavi-Eba	Co-educational	2,500
15.	Govt. Day Sec. School, Inoziomi	Co-educational	3,200
16.	Govt. Science Sec. School, Ogaminana	Co-educational	3,560
17.	Ebira Community Sec. School, Ogaminana	Co-educational	3,800
18.	Govt. Day Sec. School, Okunchi	Co-educational	2,800
19.	Okehi Community Sec. School, Ikuehi	Co-educational	1,550
20.	Okehi Community Sec. School, Oboroke	Co-educational	2,015
21.	Okehi Community Sec. School, Uboro	Co-educational	1,950
22.	Ihima Community Sec. School, Ihima	Co-educational	2,300
23.	Govt. Day Sec. School, Ohueta	Co-educational	2,100
24.	Govt. Day Sec. School, Ebako	Co-educational	1,850
25.	Govt. Girls Unity Sec. School, Oborooke	All girls	2,400
26.	Govt. Technical College, Oboroke	Co-educational	1,750
	TOTAL		**54,490**

Source: Kogi State Schools Management Board Zonal Office, Ogaminana (2020/2021)

3.3 Sample Techniques and Sample

A sampling size of 600 out of 54,490 was selected using multistage sampling technique. AT the beginning, two coeducational schools were selected using random sampling techniques from Okene Local Government Area and one from each of Adavi and Okehi Local Government Areas. Then six hundred students were further selected form these four schools which were further divided into control group and experimental groups. The distribution of the sample is given in table 3.3.

Table 3.2: Sample for the study

S/N	Name of School	Group	Total
1.	Govt. Secondary School, Okene	Control group CG, x_o)	150
2.	FCE Demonstration Sec. Sch., Okene	Experiment group (EG_1, x_1)	165
3.	Govt. Science Sec. School, Ogaminana	Experimental group (EG_2, x_2)	165
4.	Ihima Community Sec. Sch., Ihima	Experimental group (EG_3, x_3)	120
	TOTAL		**600**

3.4 Topics Selected for the Study

Eight research assistants were used in the teaching of the selected algebraic topics. The researcher trained the research assistants and equally prepared the lesson plan they used in the teaching (See appendices G-I). The teaching was done in six weeks as recommended by Sambo and Kim (2005).

Each group was taught for twelve (12) periods of thirty (30) minutes duration each. The topics covered during the treatment period were the same for all the groups as presented in table 3.3.

Table 3.3: Selection of Algebraic topics covered during the treatment period

S/N	Contents Covered	Lesson Week(s)
1	Algebraic processes: find additive and multiplicative inverse of numbers; apply inverse operation to problem-solving.	1
2	Expansion of algebraic expressions of the form a (b+c) and (a+b) (c+d).	1
3	Algebraic factors, factorization and fractions: factorise simple algebraic expressions and simplify algebraic fractions	2
4	Solving equations: Solve hander problems on simple equations, interpret and solve and problems including algebraic fractions	2

Source: NERDC (2014)

3.5 Instrumentations

The instrument used for this study included the level 1 achievement test, the level 2 achievement test and the level 3 achievement test. All were parallel tests in quality and quantity covering the same items in the syllabus. The algebraic achievement test 1, achievement test 2 and achievement test 3 consist of sets of 40 multiple choice questions, each in algebraic topics designed to find out the extent the students understand the selected algebraic concepts.

These tests items were designed by the researcher and two Ph.D. holders and Chief lecturers in the Mathematics Department of Federal College of Education, Okene. These experts made constructive contributions in the areas of content and language. The multiple choice questions consist of four response options. Only one option is correct answer while the remaining three options are good distracters.

3.5.1 Algebraic Performance Test (APT)

The Algebraic Performance Test was one of the two instruments used in this study for pre-testing, post-testing, and measuring the retention of the students in the post post-testing. Algebraic Performance Test (APT) was made of forty (40) questions selected and adapted from the work of Sambo & Kim (2005). It covered additive and multiplication inverses of numbers; expansion of algebraic expressions; factorization of simple expressions; and word problems (see table 3.4). The researcher selected the questions such that each of the topics has equivalent number of questions. Also, the test questions were arranged in order of difficulty.

3.5.2 Students Algebraic Attitude Inventory

Students Algebraic Attitudinal Inventory was the second instrument used in this study adapted from Fennema-Sherman Attitude Instrument (2003). The instrument contained sixty (60) questions with two sections; the first section was the respondent profile while the second contained the statements (items) to be responded to by the respondents.

The questionnaire was based on the five point Likert Scale Format: Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). Sub-scale of the questionnaire included: uses of confidence anxiety and motivation. Positive items were scored from 5 to 1 point while negative items have the reverse of the order (see appendices; B & C).

3.6 Validation of the Instrument

Questionnaire, performance test and the corresponding marking scheme were developed by the researcher and given to experts with minimum of Ph.D. qualification in Mathematics education (2 in number) and Measurement & Evaluation (1 in number) for validation. All three are Chief Lecturers with Federal College of Education, Okene. They were requested to critically examine and assess all the items of the instrument paying attention to the following:

(i) Whether the language of expression is simple and clear to the targeted students.

(ii) Whether the questions are clear, precise and free form ambiguity.

(iii) Whether questions match the ability level of the learners.

(iv) Whether the test conform with the subject specification and the objective of the study.

(v) Ascertain whether or not the test items were all constructed within the syllabus of junior secondary school.

The experts made constructive criticisms in areas of language level and content of achievement tests instrument. The corrections were made leading to the final selection of the 40 items and corresponding marking scheme. These corrected versions were represented to the experts which they accepted that the instruments were highly appropriate and relevant to that level the test items were meant for, and it could measure what they were to measure and free of error and ambiguity. Thus the criticising and suggestions were adequately corrected to modify the instruments before administration of the test items (Appendices B, C, D, E, F and G).

3.7 Reliability of the Instruments

Reliability is the degree of consistence to which a test, on repeated measurement, yields almost the same result when administered to learner of similar characteristics and ability levels. To test the reliability of the instruments, a pilot study was conducted in two junior secondary schools (JSS II) outside the study area: Government Secondary School, Ebiya and Comprehensive High School, Ogori.

Test-retest method was used to obtain a consistency and reliability coefficient for the Algebraic Performance Test. The instruments were administered twice with the interval of two weeks as proposed by Tuckam (1975) as cited in Ahmed (2019). Pearson Product Moment Correlation Coefficient Statistic was employed for computing the reliability index of Algebraic concepts test which was found to be r = 0.84. This implies the reliability of the test items. This was a confirmation of test of reliability by Spiegel, (1992), Stevens, (1986), and Olayiwola, (2010). According to them an instrument is considered reliable if it lies between 0 and 1, and that the closer the calculated reliability coefficient is to zero, the less reliable is the instrument, and the closer the calculated reliability co-efficient is to 1, the more reliable is the instrument. This therefore confirms the reliability of the data collection instrument used as fit for the main work.

3.8 Item Analysis

3.8.1 Difficulty Index for Algebraic Test

For standardization of the instrument, the items with difficulty index $r \geq 0.85$ is regarded as difficult while items with difficulty index $r \leq 0.25$ is regarded as easy. Therefore for this study, any item with difficulty indices between 0.30 and 0.70 were considered to be appropriate and were selected and those with very low indices were discarded, and some were re-constructed and finally selected for the study.

Difficulty index level was determined by the formula given by Atadoga (2001) as cited in Adamu (2008) as:

$$D = \frac{RU + RL}{T} x\ 100$$

Where D = difficulty indices

RU = number among students in the upper 27 percent who scored the items correctly.

RL = number among the students in the lower 27 percent who score the items correctly.

T = total number of students in each of the upper and lower groups.

3.8.2 Discriminating Power for Algebraic Test Items

This identified high and low achievers in a given tasks in Algebra Test. This discrimination index of test has ability to sort out the high and low ranking students in at est. Lawal (2009) in Adamu (2014) recommended 0.30 and 0.80 discrimination indices value for selecting good items for achievement test. For this study, items with discrimination indices between 0.30 and 0.70 were selected, and those with very low indices were discarded with some reconstructed and selected.

Discrimination index is determined by the formula given by Adamu (2014) as presented as follows:

$$D = \frac{RU + RL}{½\ T} x\ 100$$

where

D = Discrimination index

RU = the number among the upper 27% of the respondents who scored the items correctly.

RL = the number among the lower 27% of the respondents who scored the items correctly.

T = number of respondents in each of the upper and lower groups.

As earlier stated, the magnitude of discrimination indices which range from 0.30-0.70 are used in line with Adamu (2010). Therefore, the difficulty indices and discrimination indices calculated from the initial tests which did not fall within the theoretically acceptable range suitable and fall within the region for use were rejected.

3.9 Administration of the Instruments

The test covered the scheme of work and curriculum matching chart for junior secondary school year 2 for the first term. Therefore, the pre-test, post-test and post post-test are each made up of 40 multiple choice objectives. The tests were administered to determine the effects of three constructivists' pedagogies on junior secondary schools II students' performance, retention and attitudes in Mathematics.

3.9.1 Algebraic Performance Test (APT)

Algebraic Performance Test (APT) was used for the research. The test consist of 40 multiple items which were based on the topics covered namely: Algebraic processes: finding additive and multiplicative inverse of numbers, apply inverse operation to problem solving; Expansion of algebraic expressions of the form a (b+c) and (a+b) (c+d); Algebraic Factors, Factorizations and Fractions: factorizes simple algebraic expressions and simplify algebraic fractions; Solving Equations: solve harder problems on simple equations, interpret and solve word – problems including algebraic fractions. The content was restricted to junior secondary school II Mathematics syllabus.

Three performance test based on modules treated were administered to both Control and Experimental groups. Each test consists of 40 questions. This was designed to provide feedback on the progress of the students' work and their level of performance in each of the four methods; Guided-Discovery, Problem-Solving, Activity-Based and Lecture Method.

3.9.2 Algebraic Attitude Questionnaire

Students' Algebraic Questionnaire was developed by the researcher to determine students' attitudes towards Algebra before and after the treatment. The researcher used the three constructivist approaches and the conventional teaching method (lecture method). The questionnaire contains items based on the Likert Scale Format of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). This was adopted form Fennema-Sherman Instrument (1976) and was modified by the researcher. The questionnaire was based on students' perception on algebra, uses of algebra, confidence and anxiety in learning algebra and motivation towards the subject.

3.10 Administration of the Treatment

The teacher-centred methods (lecture method) of teaching and the three constructivists' pedagogies (Guided-Discovery, Activity-Based and Problem-Solving) were used as treatments in the study. The treatments were administered on equal basis for the Experimental groups. One group was exposed to guided-discovery, another one was exposed to activity-based while the third group was exposed to problem-solving under the guidance of the researcher. The control group was taught using the lecture method.

3.10.1 Lecture Method

Teacher-centred method was purely used to teach the selected algebra topics taken from the scheme of work and curriculum matching chart for junior secondary school II for first term (Appendix A). The teacher is seen as the one that knows and has the knowledge and facts which he wants to teach the students. The teacher passes the information as message to the students using majorly the "chalk-and-talk" method.

The researcher focuses essentially on teaching the topics. He followed the arrangement in the scheme of work as topics have been ascribed to each week and performance objectives stated. By this, the scheme of work serves as a guide to the researcher as the document determines what ought to be taught, when, how and in what time frame. The researcher made use of conventional teaching method only to deliver the message to the students. This goes by lecture method, class work, homework, questions and answers. Students equally made to copy worked examples from the chalkboard in their Mathematics notebooks.

3.10.2 Constructivists: Guided-Discovery, Problem-Solving and Activity-Based Strategies

The researcher made use of guided-discovery, problem-solving and activity-based strategies through role-playing, cooperating learning system and Mathematics games to present and convey information to the students. The aim of these approaches is to encourage students to solve problems, use activity-based and guided-discovery methods themselves. The scheme of work provided the topics to be taught on weekly basis and the performance objectives to be obtained within a specified time frame.

3.11 Procedure for Data Collection

This study investigated the effect of constructivist approaches to teaching on junior secondary school students' performance, retention and attitudes in Mathematics. A period of five (5) weeks of first term, 2020/2021 session, was used to give instructions in Mathematics using the traditional teaching method (lecture method) and the three constructivist pedagogies (guided-discovery, problem-solving and activity-based). A comparison of the results between the control group and the experimental groups were made.

The pre-test, post-test and post post-test were administered to both the control group and the experimental groups before and after treatment by the researcher in each of the sample size respectively. The tests were administered in the mornings before 10 a.m. when the students were not stressed up and without prior notice about the tests. This was done in order to minimize test phobia and cheating by the students.

The researcher sought the cooperation of the research assistants from Federal College of Education, Okene. The subject teachers in each of the schools arranged the classes to create an enabling and conducive environment for the research assistants. This arrangement ensured orderliness and effective management. Writing materials in the form of sheets of paper, pencils and <learners were provided by the researcher. The multiple choice objective tests were typed by the researcher. the time allocated to each test was an hour. The subject teacher, the research assistants and the researcher jointly administered the test questions and they all attended to students' difficulties during the test period.

The Algebra Performance Test (APT) and Students Attitudes Questionnaire (SAQ) were administered. The mean scores of the Algebra Performance Tests for pre-test, post-test and post post-test for EG_1, EG_2, EG_3 and control group were calculated and recorded before and after the treatment. This is to know whether the use of thee strategies have effects on students' performance, retention and attitudes towards the algebraic contents. Algebraic Performance Test consisted of 40 questions and each question was allotted 2.5 marks making a total mark of 100%.

3.12 Procedure for Data Analysis

The data to be collected will be analyzed using both descriptive and inferential statistics The questions will be answered with descriptive statistics using mean and standard deviations in order to deter mine if there is effect of the constructuive strategies on retention and performance of Algebra performance ogf the students in the first two questions while the mean Rank attitude will be used to answer question three top determine effect of the constructive strategies in students level of attitudes towards the algebra . In testing the null hypotheses, the Regression analysis would be used to test hypotheses 1 to 4 since each sought to determine the level of independent variables (teachers qualifications and teachers pedagogical skills) as predictor to the dependent variables (student academic performance and students interest towards basic science at JSS) All the hypotheses would be tested at 0.05 level of significance

The research questions to be answered are:

i. What is the effect of constructivist approaches to teaching on junior secondary school students' performance in Algebra?

ii. What is the effect of constructivist approaches to teaching on junior secondary school students' retention in Algebra?

iii. What is the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra?

The null hypotheses to be tested are:

H_{O1}: There is no significant difference between the mean scores of academic performance of students taught algebra with constructivist approaches compare to the use of conventional teaching method. The data collected from Performance test is parametric (interval scale). Therefore, the researcher used ANOVA (F-Test).

H_{O2}: There is no significant difference between the mean scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The data collected from H_{o2} was meant to test Retention. The data being parametric (interval), the researcher used ANOVA (F-Test).

H_{O3}: There is no significant difference in the attitude of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The data collected being non-parametric, the researcher used Krushal Walli (H-Test).

. The test was calculated based on alpha value of (< = 0.05) level of significance.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

4.0 Overview

This study examined the effects of constructivist approaches to teaching compared to the use of conventional teaching method on academic performance, retention and attitude among Junior Secondary School students in Algebra. A total of 600 students were used. While 150 were taught with Lecture Method, the rest were divided into three groups and taught with Problem-Solving, Guided-Discovery and Activity-Based of the constructivist approaches and also used to discussed the following research questions

(i) What is the effect of constructivist approaches to teaching on junior secondary school students' performance in Algebra?

(ii) What is the effect of constructivist approaches to teaching on junior secondary school students' retention in Algebra?

(iii) What is the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra?

The first section of the analysis presents the bio data variables of study groups, gender, schools of respondents in frequencies and percentages, while the second section used the descriptive mean statistics or mean rank statistics to answer the research questions and the third section test the three null hypotheses using the Analysis of Variance **(ANOVA)** to test for hypotheses one and two on mean scores and retention level respectively while the third hypothesis was tested with the Kruskal Walis non-parametric statistics. All the hypotheses were tested at 0.05 alpha level of significance.

4.1 Presentation of Bio Data Variables

Table 4.1: Group Distribution of the Experimental Groups and the Control Groups

Study Groups	Frequency	Percent
Exp1 Problem Solving	165	27.5
Exp2 Guided Discovery	165	27.5
Exp3 Activity Based	120	20.0
Control	150	25.0
Total	**600**	**100.0**

On the basis of the respondents study groups, a total of 165 or 27.5% are exposed to Problem-Solving Experimental group 1 while another 165 or 27.5% were exposed to Guided-Discovery Experimental 2 group while 120 or 20.0% are exposed to Activity-Based method classified as Experimental group 3. The rest 150 or 25.0% were taught with the lecture method classified as control group. All the three experimental groups are known as the constructivist approaches.

Table 4.2: Distribution of the Respondents According to Schools

School	Frequency	Percent
FCE Demonstration Sec. Sch., Okene	165	27.5
Govt. Science Sec. School, Ogaminana	165	27.5
Ihima Community Sec. Sch., Ihima	120	20.0
Govt. Secondary School, Okene	150	25.0
Total	**600**	**100.0**

The respondents schools revealed that 165 or 27.5% are from FCE Demonstration Sec. Sch., Okene, while another 165 or 27,5% are from Govt. Science Sec. School, Ogaminana as against 120 or 20.0% that are from Ihima Community Sec. Sch., Ihima and the rest 150 or 25.0% are from Govt. Secondary School, Okene.

Table 4.3: Gender Distribution of Respondents

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	391	65.2	65.2	65.2
Female	209	34.8	34.8	100.0
Total	**600**	**100.0**	**100.0**	

The respondents gender stats showed that while a total of 391 representing 65.2% are male students the rest 209 representing 34.8% are female students.

4.2 Research Questions and Hypotheses Testing

4.2.1 Research Question One:

What is the effect of constructivist approaches to teaching on junior secondary school students' performance in Algebra?

Table 4.4: Descriptive Mean statistics on difference between the mean scores of academic performance of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

Study Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Exp1 Problem Solving	165	40.4091	5.31400	.41369	39.5922	41.2259
Exp2 Guided Discovery	165	39.1848	4.68659	.36485	38.4644	39.9053
Exp3 Activity Based	120	39.0875	4.46634	.40772	38.2802	39.8948
Control	150	33.3167	5.11919	.41798	32.4907	34.1426
Total	**600**	**38.0350**	**5.65158**	**.23072**	**37.5819**	**38.4881**

Results of the descriptive mean statistics showed that constructivist approaches have great effect on junior secondary school students' performance in Algebra.

The computed mean scores of the three constructivist approaches shows 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. The Mean comparison test using the Scheffe test showed that while the mean scores of the control group was put at significantly lower subset 1, the mean scores of the three constructivist approaches were put together at a significantly higher subset 2. This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method.

4.2.2 Ho1: There is no significant different between the academic performances of students who were taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

Table 4.5: Analysis of Variance (ANOVA) statistics on difference between the mean scores of academic performance of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

	Sum of Squares	Df	Mean Square	F computed	F critical.	P value
Between Groups	4620.477	3	1540.159	63.254	3.000	0.000
Within Groups	14511.788	596	24.349			
Total	19132.265	599				

p value =0.000, F computed =63.254, P>0.05, F computed > f critical at df 3

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Mean Performance

Scheffe

(I) Study Groups	(J) Study Groups	Mean Difference (I-J)	Std. Error	Sig.
Exp1 Problem Solving	Exp2 Guided Discovery	1.22424	.54326	.167
	Exp3 Activity Based	1.32159	.59201	.174
	Control	7.09242*	.55668	.000
Exp2 Guided Discovry	Exp1 Problem Solving	-1.22424	.54326	.167
	Exp3 Activity Based	.09735	.59201	.999
	Control	5.86818*	.55668	.000
Exp3 Activity Based	Exp1 Problem Solving	-1.32159	.59201	.174
	Exp2 Guided Discovry	-.09735	.59201	.999
	Control	5.77083*	.60434	.000
Control	Exp1 Problem Solving	-7.09242*	.55668	.000
	Exp2 Guided Discovry	-5.86818*	.55668	.000
	Exp3 Activity Based	-5.77083*	.60434	.000

*. The mean difference is significant at the 0.05 level.

Homogeneous Subset

Mean_Performance

Scheffe[a,b]

Study Groups	N	Subset for alpha = 0.05 1	2
Control	E	33.3167	
Exp3 Activity Based	120		39.0875
Exp2 Guided Discovry	165		39.1848
Exp1 Problem Solving	165		40.4091
Sig.		1.000	.153

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 147.486.

Results of the Analysis of Variance (ANOVA) statistics showed that significant difference exist between the mean scores of academic performance of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

The ANOVA statistics table showed that the calculated p value of 0.000 is lower than the 0.05 alpha level of significance and the computed F value of 63.254 is higher than the 3.000 F critical value at df 3.

The computed mean scores of the three constructivist t approaches are 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. The Mean comparison test using the Scheffe test showed that while the mean scores of the control group was put at significantly lower subset 1, the mean scores of the three constructivist approaches were put together at a significantly higher subset 2. This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method.

Therefore the null hypothesis which states that there is no significant difference between the mean scores of academic performance of students taught Algebra with constructivist approaches compare to the use of conventional teaching method, is hereby rejected.

The discussions on findings would be done vis-a-vis the outcome of each research hypotheses and their corresponding questions and as they support or contradict some of the literature quoted in this study.

Discussion of findings on research question one and hypothesis one revealed that, in the test of hypothesis one using the Analysis of variance revealed that significant difference exist between the mean scores of academic performance of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. in fact it showed that The computed mean scores of the three constructivist t approaches are 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. The Mean comparison test using the Scheffe test showed that while the mean scores of the control group was put at significantly lower subset 1, the mean scores of the three constructivist approaches were put together at a significantly higher subset 2. This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method. This necessitated the rejection of the null hypothesis.

This outcome is expected because it is supported by Padmavathi (2013) as cited in Zekerya Akkus (2015), Alumba (2008) and Muhammed (2017) s all posited that the three constructivists' strategies of problem solving methods, guided discovery approach and Activity based approach are all child centred, developing the child's intellect and arousing the child's willingness to learn more while on the other side the lecture method otherwise called the conventional teaching method is only teacher centred and hence the students are not carried along, their individual learning speed are not considered with conventional method in teaching/learning environment to help students learn Mathematics. Evidences from the review showed that using activity-based, problem-solving and guided-discovery strategies in the teaching/learning

Mathematics brings about increased Mathematics achievement, retention positive attitudes change in learners.

Therefore, using the three constructivists' strategies that is activity-based, problem-solving, and guided-discovery other researchers have not utilized simultaneously with teacher-centred approach, will lead to quantum lift in Mathematics achievement among students.

4.2.3 Research Question Two:

What is the effect of constructivist approaches to teaching on junior secondary school students' retention in Algebra?

Table 4.6: Descriptive Mean statistics on the effect of constructivist approaches to teaching on junior secondary school students' retention in Algebra

Study Group	N	Mean	Std. Deviation	Std. Error	Remarks
Exp1 Problem Solving	165	65.6485	4.44589	.34611	The three constructivist approaches have positive effect on students retention scores in algebra
Exp2 Guided Discovery	165	58.5091	4.87980	.37989	
Exp3 Activity Based	120	56.7750	4.56781	.41698	
Control	150	44.9267	5.30303	.43299	
Total	600	56.7300	8.98564	.36684	

Results of the descriptive mean statistics revealed that constructivist approaches have high positive effect to teaching on junior secondary school students' retention in Algebra.

The computed scores of retention shows 44.926, 56.775, 58.509 and 65.648 by students taught with lecture method, Activity based, guided discovery and problem solving respectively.

The Mean comparison test using the Scheffe test showed that while the scores of retention of the control group was put at significantly lower subset 1, that of the Activity based in subset 2, while guided discovery at subset 3 and problem solving at significantly highest at subset 4. This shows that while the retention scores of lecture method is the least at subset 1, the constructivist approaches retention scores were put at significantly higher subset 2 for activity based, subset 3 for guided discovery and subset 4 for problem solving groups. This shows that the scores of retention of the students taught with the three constructivist approaches have scores of retention that are significantly higher than those taught with the lecture method.

4.2.4 Ho2: There is no significant difference between the retention of students taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

Table 4.7: Analysis of Variance (ANOVA) statistics on difference between the scores of Retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

ANOVA

Retention

	Sum of Squares	Df	Mean Square	F computed	F critical	Sig.
Between Groups	34544.293	3	11514.764	496.586	3.00	.000
Within Groups	13819.967	596	23.188			
Total	**48364.260**	**599**				

p value =0.000, F computed = 496.586, P>0.05, F computed > f critical at df 3

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Retention

Scheffe

(I) Study Groups	(J) Study Groups	Mean Difference (I-J)	Std. Error	Sig.
Exp1 Problem Solving	Exp2 Guided Discovry	7.13939*	.53016	.000
	Exp3 Activity Based	8.87348*	.57772	.000
	Control	20.72182*	.54325	.000
Exp2 Guided Discovry	Exp1 Problem Solving	-7.13939*	.53016	.000
	Exp3 Activity Based	1.73409*	.57772	.030
	Control	13.58242*	.54325	.000
Exp3 Activity Based	Exp1 Problem Solving	-8.87348*	.57772	.000
	Exp2 Guided Discovry	-1.73409*	.57772	.030
	Control	11.84833*	.58976	.000
Control	Exp1 Problem Solving	-20.72182*	.54325	.000
	Exp2 Guided Discovry	-13.58242*	.54325	.000
	Exp3 Activity Based	-11.84833*	.58976	.000

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Retention

Scheffe[a,b]

		Subset for alpha = 0.05			
Study Groups	N	1	2	3	4
Control	150	44.9267			
Exp3 Activity Based	120		56.7750		
Exp2 Guided Discovery	165			58.5091	
Exp1 Problem Solving	165				65.6485
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 147.486.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Results of the Analysis of Variance (ANOVA) statistics showed that significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

The ANOVA statistics table showed that the calculated p value of 0.000 is lower than the 0.05 alpha level of significance and the computed F value of 496.586 is higher than the 3.000 F critical value at df 3.

The computed scores of retention are 44.926, 56.775, 58.509 and 65.648 by students taught with lecture method, Activity based, guided discovery and problem solving respectively.

The Mean comparison test using the Scheffe test showed that while the scores of retention of the control group was put at significantly lower subset 1, , that of the Activity based in subset2, while guided discovery at subset 3 and problem solving at significantly highest at subset 4. This shows that while the retention scores of lecture method is the least at subset 1, the constructivist approaches retention scores were put at significantly higher subset 2 for activity based, subset 3 for guided discovery and subset 4 for problem solving groups. This shows that the scores of retention of the students taught with the three constructivist approaches have scores of retention that are significantly higher than those taught with the lecture method.

Therefore the null hypothesis which states that there is no significant difference between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method is hereby rejected.

Discussion of findings on research question two and hypothesis two revealed that, in the same vein the test of hypothesis two using Analysis of variance and research question two using descriptive statistics revealed that significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed scores of retention are 44.926, 56.775, 58.509 and 65.648 by students taught with lecture method, Activity based, guided discovery and problem solving respectively.

This was readily supported by Ogawa (2001) in Ohisen (2007), Sambo (2005) and Ogawa (2001) who all believed that Modern teaching methods in education are child-centred, the exact mandate of constructivism and that the most important nature of constructivist approach is interest, student-centred, activity-based, retentive and lead the students to have Mathematical power. Constructivist approach assumed that the learners came to the class with their experiences which stressed that the teacher's role is to only guide and encourage the student. The students are actively involved in the learning activities thus they are active learners and this certainly will build the students level of retention since he is the one that is actively involved in the teaching process unlike the conventional method that he is not engaged in and certainly erode his level of retention ability Therefore, using the three constructivists' strategies that is activity-based, problem-solving, and guided-discovery other researchers have not utilized simultaneously with teacher-centred approach, will lead to quantum lift in retention ability of the mathematics students.

4.2.5 Research Question Three:

What is the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra?

Table 4.8: Non parametric Mean Rank statistics on test on the effect of constructivist approaches to teaching on junior secondary school students' attitude towards Algebra

Study Groups	N	Mean Rank	Remarks
Exp1 Problem Solving	165	359.08	The three constructivist approaches have increased the school students' attitude towards Algebra
Exp2 Guided Discovery	165	363.23	
Exp3 Activity Based	120	351.81	
Control	150	126.01	
Total	**600**		

Results of the non-parametric test above revealed that the constructivist approaches have very high positive effect to teaching on junior secondary school students' attitude towards Algebra.

The computed Mean Rank attitude of the three constructivist approaches are 359.08, 363.23, 351.81 and 126.01 for students taught with problem solving, guided discovery, activity based and control method respectively. This shows that the mean Rank attitude of the three constructivist approaches are significantly higher than those of lecture method 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. .

4.2.6 Ho3: There is no significant difference between the Attitude of students taught Algebra with constructivist teaching approaches and those who were taught using the conventional teaching approaches.

Table 4.9: Kruskal Walis Non parametric test on difference in the attitude of students taught Algebra with constructivist approaches compare to the use of conventional teaching method

Ranks

	Study Groups	N	Mean Rank	df	X^2	X^2	P value
ATTITUDE	Exp1 Problem Solving	165	359.08	3	203.06	**7.815**	0.001
	Exp2 Guided Discovery	165	363.23				
	Exp3 Activity Based	120	351.81				
	Control	150	126.01				
	Total	600					

$p < 0.05$, X2 computed > X2 critical at df 3

From the outcome of the table above, the Kruskal Walis non-parametric test above revealed that significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method.

The Kruskal Walis statistics table showed that the calculated p value of 0.001 is lower than the 0.05 alpha level of significance and the computed X^2 value of 203.06 is greater than the 7.815 X^2 critical value at df 3.

The computed Mean Rank attitude of the three constructivist approaches are 359.08, 363.23, 351.81 and 126.01 for students taught with problem solving, guided discovery, activity based and control method respectively. This shows that the mean Rank attitude of the three constructivist approaches are significantly higher than those of lecture method 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. The Mean comparison test using the Scheffe test showed that while the mean scores of the control group was put at significantly lower subset 1, the mean scores of the three constructivist approaches were put together at a significantly higher subset 2. This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method.

Therefore the null hypothesis which states that there is no significant difference in the attitude of students taught Algebra with constructivist approaches compare to the use of conventional teaching method is hereby rejected.

Discussion of findings on research question three and hypothesis three revealed that, the test of hypothesis three using non parametric test showed that significant difference exist between the scores of attitude of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed Mean Rank attitude of the three constructivist approaches are 359.08, 363.23, 351.81 and 126.01 for students taught with problem solving, guided discovery, activity based and control method respectively. This shows that the mean Rank attitude of the three constructivist approaches are significantly higher than those of lecture method 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316 This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method. This was why the null hypothesis was consequently rejected.

In discussing this outcome it is very obvious according to Atkins (2008), Mandrin and Preckel (2011), Dean and Kuhu (2006) all corroborated this outcome by positing that when constructivist approaches are used to teach mathematics, the attitude of the students towards learning mathematics in the students is significantly increased. The students being the center point and the main active person in the constructivist approaches is always looking forward to improving in the subject, they develop positive attitude towards the learning and teaching of mathematics. While on the other hand they exhibit lesser fair attitude if the lecture method which is only teacher based is to be used in the teaching process

4.3 Summary of the Major Findings

As stated earlier, this study was set to investigate the effect of constructivist approaches to teaching compared to the conventional approach on academic performance and retention in Algebra among Junior Secondary School Students in Okene Metropolis, Kogi State, Nigeria. It was carried out through a quasi-experiment using Problem-Solving, Guided Discovery and Activity-Based as the constructivist strategies while comparing their effects with conventional teaching method (lecture method).

Two sets of data were collected. The data on attitude and that of performance were collected before the students were exposed to the constructivist strategies. After the exposure, data on academic performance, retention and attitude were collected too. Three research questions were raised along the specific objectives and tested with three null hypotheses. Data collected were analyzed with the statistical package for the social science (SPSS). Therefore, the following are the summary of the major findings of the study:

1. Ssignificant difference exist between the mean scores of academic performance of students taught Algebra with constructivist approaches compared to the use of conventional teaching method. The computed mean scores of the three constructivist approaches are 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316 This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method. **p value =0.000, F computed = 63.254, P>0.05, F computed > f critical at df 3.**
2. Significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed scores of retention are 44.926, 56.775, 58.509 and 65.648 by students taught with lecture method, Activity based guided discovery and problem-solving respectively. This shows that the scores of retention of the students taught with the three constructivist approaches have scores of retention that are significantly higher than those taught with the lecture method. **p value =0.000, F computed = 496.586, P>0.05, F computed > f critical at df 3.**
3. Significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed Mean Rank attitude of the three

constructivist approaches are 359.08, 363.23, 351.81 and 126.01 for students taught with problem solving, guided discovery, activity based and control method respectively. This shows that the mean rank attitude of the three constructivist approaches are significantly higher than those of lecture method 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316. . This shows that the mean scores of the students taught with the three constructivist approaches have mean scores significantly higher than those taught with the lecture method. ***p < 0.05, X2 computed > X2 critical at df 3.***

CHAPTER FIVE

SUMMARY, CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES

5.0 Overview

This chapter presents the discussion of findings, summary, conclusions, recommendations, suggestions for further study, and limitation of the study.

5.1 Summary

This section presents the summary of the entire work on the effect of constructivist approaches to teaching compared to the conventional approach on academic performance and retention in Algebra among Junior Secondary School Students in Okene Metropolis, Kogi State, Nigeria. It was carried out through a quasi-experiment using Problem-Solving, Guided Discovery and Activity-Based as the constructivist strategies while comparing their effects with conventional teaching method (lecture method). The study was carried out through five chapters which the sections summarizes, therein.

The first chapter presented the background of the study stating explicitly that Mathematics is given adequate attention and emphasis in the Nigerian school curriculum, right from primary through secondary to tertiary institutions. It is compulsory subject that must be passed at credit level by students before gaining admission into tertiary institutions in the country. Suffice to say therefore that Mathematics has an important role to play in the task of nation building and development. Hence Ibrahim (2012) described Mathematics as the queen, the servant and language of the sciences. Of course, science is an important tool for meaningful development.

Passing examinations at all cost by students to secure unmerited certificates, is to many people the goal of going to school rather than acquiring useful knowledge, skills and experience with which to cope with the demands of modern and real life. This negative mind-set has made success in public examinations a do-or-die affair amongst students (Kajuru, 2010).

Nigeria, as a developing nation, has formulated many educational policies and programmes under the umbrella; National Policy on Education (FME, 2014). The major aim of the constant review of the nation's education policies and programmes is to address inherent mistakes in the existing ones and meet up the world best practice. This National Policy on Education identified the following as the causes of poor performance of students in public examinations: the use of archaic teaching methods, lack of instructional materials, over-crowded classroom, poorly or untrained teachers, just to mention but this few. . The statement of problem chronicled that this poor performance is heavily blamed on the teacher-centred pedagogy used in teaching Mathematics. For instance, Emaikwu (2012) stated that inadequacy of conventional teaching models used by Mathematics teachers reduces students' interest, achievement and retention ability. Azuka (2003) and Missildinel (2004) cited by Muhammed (2017), commented on the ways, manner and approaches used by Nigerian Mathematics teachers as inappropriate. They remarked that low achievement in Mathematics is caused by the teachers' non-utilization of appropriate teaching approaches to Mathematics. Besides, Ado (2014) opined that little attention is paid to the learners' attitude towards Mathematics vis-à-vis their performance. The study was built around a main objective which was to investigate the effect of constructivist approaches to teaching on junior secondary school students' performance, retention and attitude in Algebra within Okene metropolis of Kogi State, Nigeria. That was divided into three specific objectives to which three research questions were postulated that were answered and three null research hypotheses formulated that were tested. The significance of the study was hinged on the facts that The Nigerian public today is on high demand that the nation's schools provide effective education to keep pace with a rapidly changing world in all ramifications. Going by the roles of Mathematics towards national development, there is the need for improvement in the teaching and learning processes of the subject. Therefore, the findings of this study would hopefully provide the following benefits and It would give teachers additional resources and options to use and provide the ability to present difficult concepts to most students. Also, the study showcased constructivist pedagogies as against teacher-centred method. As a child-centred method, it has a lot of benefits to the learners and teachers both on short and long term basis. The study assumed among others that The schools under study are similar based on curriculum contents and syllabus used and The students that were used for the study have covered the junior secondary schools 1 Mathematics curriculum and as such familiar with Algebra concepts in Book as well as the fact that The students that were used for the study were not familiar with the constructivist approaches. The study scope and limitations is The selected Mathematics topics in Algebra used for the study were taken from the National Education and Research Development Council (NERDC) curriculum for JSS II based on a 3-term, 10 weeks per term in the school year. The selected junior secondary schools from the Okene Educational Metropolis are all public schools. These are: FCE Demonstration Secondary Schools, Okene; Government Science Secondary School, Ogaminana and Ihima Community Secondary School, Ihima; with at least a school from each of three Local Government Areas within Okene Metropolis. Again variables like personal perception of algebraic concepts and poor performance in algebraic topics were correlated using some inferential statistics like correlation analysis, regression and t-test. Also, some descriptive statistics were used to test students' performance and retention.

The second chapter was based generally on the over view of theoretical framework, conceptual framework, problem-solving, guided-discovery, activity-based, conventional teaching method, performance of students in Algebra, retention of students in Algebra, attitude of students towards Algebra, overview of related studies and implications of literature reviewed on the present study. The conceptual framework included among others Algebra comes from the Arabic word: al-jabr, meaning reunion of broken parts and bone setting (Menini, et al, 2017). The Persian Mathematician; Muhammed Ibn Musa al-Khwarizmi (780-850) wrote and published in 830 "The Compendious Book on Calculation by Completion and Balancing" which established algebra as a mathematical discipline that is independent of geometry and arithmetic (Roshidi Rasheed, 2009). Al-Khwarizmi's contribution was fundamental. He solved Linear and Quadratic equations without algebraic symbolism, negative numbers or zero. Thus, he had to distinguish several types of equations. Therefore, in the context of identification with rule for manipulating and solving equations, al-Khwarizmi is regarded as "the Father of Algebra" (Christiandis, 2007).

Boyer (1991) pointed out too that al-Khwarizmi introduced the method of 'reduction and balancing' (i.e. the transposition of subtracted terms to the other side of the equation leading to cancellation of like-terms in opposite sides of the equation) which the term al-jabr originally referred to: Elementary algebra is the most basic form of algebra. It is taught to students who are presumed to have no knowledge beyond basic principles of arithmetic. Unlike in arithmetic where only numbers and their arithmetical operations (such as +, -, x, ÷) occur, in algebra, numbers are often represented by symbols called variables (such as a, n, x, y or z). It has been suggested that elementary algebra should be taught to students as young as eleven years old (Hull's Algebra, 2012). In Nigeria, algebra is introduced to students as from Junior Secondary School 1 (i.e. 12 years). The theoretical frame work among others detailed Modern teaching method in education is child-centred, the exact mandate of constructivism. Sambo (2005) is of the view that the most important nature of constructivist approach is interest, student-centred, activity-based, retentive and lead the students to have Mathematical power. Constructivist approach assumed that the learners came to the class with their experiences. The teacher's role is to guide and encourage the student. The students are actively involved in the learning activities thus they are active learners.

Philosophically, constructivist approach is a learning process founded on the premise that by reflecting on our experiences, we can construct our own understanding of the world around us. Ogawa (2001) in Ohisen (2007) described constructivism as an epistemology; a theory of knowledge related to objectivism, where knowledge is viewed as existing outside the bodies of cognizing beings. Constructivism simply means that people have the ability to construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Ahmed, 2019). Constructivism emphasizes the building (construction) that occurs in learners mind when they learn new concepts. Therefore, students learn faster and achieve better retention when learning is based on problem-solving activity. The three constructivist approaches visa- visa problem solving, Activity based approach, discovery approach were lengthy defined and the lecture method as the control group students

The second is the activity based various activity-based teaching strategies have been employed for the purpose of improving the teaching and learning of basic science at the JSS level. These strategies include inquiry method, demonstration method, process approach, cooperate learning and laboratory activity method. (Usman, 2007). In December 2005, the National Council on Education (NCE) directed Nigerian Educational Council (NERDC) to carry out the assignment of reviewing and restructuring the then existing curriculum for primary and junior secondary schools to fit into 9 year basic education programme. This 9 year basic education programme stipulated the child should spend 9 years in primary and junior secondary school levels. The guided discovery approach has been defined in different ways by different scholars. Alumba (2008) sees it as mental assimilation y which the individual learner learning of concept or principle resulted from physical and mental activity carried out by the learner. The teacher ensures that the students have a chance to form a concept by studying subjects before leading the students to form the generalization. Mandrin and Preckel (2011) describe enhanced discovery learning as a process that involves preparing the learner for the discovery learning task by providing the necessary knowledge needed to successfully complete said task. In this approach, the teacher not only provides the necessary knowledge required to complete the task, but also provides assistance during the task. Performance can be defined as the quality of results produced by students as reflected in the quality of their examination scores (Musa, 2000). In recent years, that quality of most completers of educational institutions in Nigeria falls below the expected academic competence stated in the National Policy on Education (FGN, 2014). For example, Nigeria is still producing graduates with little problem-solving skills and slow analytical minds (Punch, 2015). This has been attributed largely to poor teaching methods by the teachers resulting from the poor quality teacher-education. The poor teacher-education can be traced back to 1977 introduction of Universal Primary Education (UPE). According to Ahmed (2019), the implementation of the UPE programmes required large number of trained Grade II teachers for successful take off, but regrettably was in short supply in 1977. To make-up for the short supply of these Grade II teachers, a teacher-education policy known as "crash programme" was introduced with admission requirement into Grade II Teachers' Training Colleges lowered. On completion of the programme, all teacher trainees, whether passed, referred or failed, were offered automatic employment and deployed to primary schools (and some to secondary schools) as teachers. This resulted in half-baked teachers taken charge of classrooms and teaching became a profession for all comers.

Attitude is an organization of beliefs, feelings and behavioural tendencies towards an object (Vaughang, 2005). Ado (2014) defined attitude as a mental or neutral state of readiness, organised through experience, exerting a directive and dynamic influence upon the individual's response to all objects or situation with which it is related. Furthermore, Salman, et al., (2012) described attitude as effective by-product of an individual's experiences. That is to say, attitudes results from personal desires and group stimulation. Thus attitudes are the products of related beliefs and values.

Retention the last variable in the study was defined by Chianson, et al., (2011) as the ability to remember things. Kudu and Tytoo (2002) described retention as the individual's ability to hold in the mind the acquired knowledge and skills and apply same when the need arises. Furthermore, Ruhrer and Taylor (2006) state that perhaps no mental ability is more important than our capacity to learn, but the benefits of learning are lost once the material is forgotten. Such forgetting is particularly common for knowledge acquired in school, and much of this material is lost within days or weeks of learning.

Mathematics educators and researchers have pointed out that the use of conventional teaching methods by Mathematics teachers have invariably resulted in poor performance of students in teacher-made tests and standardized examinations. Research findings have shown that there is a positive relationship between integrated and single teaching strategies and students' achievement and retention in Mathematics. Sivak (2013) used a combination of teaching methods in teaching students at Green Holly Elementary School, USA. He reported that the students taught with integrated method improved significantly more than those taught with single method. Similarly, Schofield (2004) cited in Anyor (2014) reported that by combining basic skill instruction, discovery learning and conceptual learning, he recorded a significant improvement in achievement and retention among students taught with combined strategies than those taught with single strategy. Lastly each of the three constructivist approaches was compared with the lecture teaching method

Chapter three was viewed along the study methodologies which covered the method and procedure used in conducting the study. It includes the research design, population of the study, sampling technique/sample, topic selected for the study, instrumentation, validation, reliability of the instruments, item analysis, administration of the instrument, administration of the treatment, procedure for data collection and procedure for data analysis. The design adapt pre-test, post-test, post post-test experimental and control groups design (Kerlinger, 2000 & Sambo, 2005). This is a situation where students received the pre-test and after receiving treatment, they were subjected to the post-test and post post-test using the same materials of the instrument to check if there were any positive or negative changes.

The design contain three (3) types of Experimental Group called EG_1, EG_2, EG_3, and one (1) control group called CG; and 0_1 = pre-test, 0_2 = post-test, 0_3 = post post-test in order to determine the academic performance, retention and attitude of four groups of students. These tests items were designed by the researcher and two Ph.D. holders and Chief lecturers in the Mathematics Department of Federal College of Education, Okene. These experts made constructive contributions in the areas of content and language. The multiple choice questions consist of four response options. Only one option is correct answer while the remaining three options are good distracters. The first instrument is the **Algebraic Performance Test (APT) which was** one of the two instruments used in this study for pre-testing, post-testing, and measuring the retention of the students in the post post-testing. Algebraic Performance Test (APT) was made of forty (40) questions selected and adapted from the work of Sambo & Kim (2005). It covered additive and multiplication inverses of numbers; expansion of algebraic expressions; factorization of simple expressions; and word problems (see table 3.4). The researcher selected the questions such that each of the topics has equivalent number of questions. Also, the test questions were arranged in order of difficulty. The other instrument is the Students Algebraic Attitude Inventory which was used in this study adapted from Fennema-Sherman Attitude Instrument (2003). The instrument contained sixty (60) questions with two sections; the first section was the respondent profile while the second contained the statements (items) to be responded to by the respondents.

The questionnaire was based on the five point Likert Scale Format: Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). Sub-scale of the questionnaire included: uses of confidence anxiety and motivation. Positive items were scored from 5 to 1 point while negative items have the reverse of the order (see appendices; B & C).

. The population of study covers all the public secondary school students from the three Local Government Areas of Okene, Okehi and Adavi which form the Okene Metropolis of Kogi State, Nigeria for 2020/2021 academic year with a total population of 54,490. In line with Sambo and Kim (2005), the focus is on junior secondary school (JSS II) students of these public schools. Junior secondary school (JSS I) was not to be used because they were newly introduced to algebraic concepts while junior secondary school (JSS III) are busy with the preparation for their junior secondary school certificate examination. The students were between the age of 12 and 13 years and they were males and females. They have the same average academic background.. A sample size of 600 out of 54,490 was selected using multistage sampling technique. AT the beginning, two coeducational schools were selected using random sampling techniques from Okene Local Government Area and one from each of Adavi and Okehi Local

Government Areas. Then five hundred and fifty students were further selected form these four schools which were further divided into control group and experimental groups. Three different instruments were used; this included the students test or performance, their retention leaves as well as their attitude towards algebra. The instruments were validated through using test retest to determine reliability, and item analysis comprising the items discriminatory index and difficult index were all carried out. In administering the instruments, the teacher-centred method (lecture method) of teaching and the three constructivists' pedagogies (Guided-Discovery, Activity-Based and Problem-Solving) were used as treatments in the study. The treatments were administered on equal basis for the Experimental groups. One group was exposed to guided-discovery, another one was exposed to activity-based while the third group was exposed to problem-solving under the guidance of the researcher. The control group was taught using the lecture method.

Chapter four was based on the presentation, and interpretation of the data obtained from the subjects in this study. The main summary of findings showed that Ssignificant difference exist between the mean scores of academic performance of students taught Algebra with constructivist approaches compared to the use of conventional teaching method. The computed mean scores of the three constructivist approaches are 39.087, 39.184 and 40.409 for students of Activity based, guided discovery and problem solving while the mean scores of control group was 33.316 . **p value =0.000, F computed = 63.254, P>0.05, F computed > f critical at df 3.,** AlsoSignificant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed scores of retention are 44.926, 56.775, 58.509 and 65.648 by students taught with lecture method, Activity based guided discovery and problem-solving respectively.. **p value =0.000, F computed = 496.586, P>0.05, F computed > f critical at df 3.**and lastly but not the least, Significant difference exist between the scores of retention of students taught Algebra with constructivist approaches compare to the use of conventional teaching method. The computed Mean Rank attitude of the three constructivist approaches are 359.08, 363.23, 351.81 and 126.01 for students taught with problem solving, guided discovery, activity based and control method respectively ***p < 0.05, X2 computed > X2 critical at df 3.***

The chapter five presented the discussion on findings from the study analysis visa-visa the outcome of the hypotheses. Results of hypothesis one was supported by Padmavathi (2013) as cited in Zekerya Akkus (2015), Alumba (2008) and Muhammed (2017), all posited that the three constructivists' strategies of problem solving methods, guided discovery approach and Activity based approach are all child centred, developing the child's intellect and arousing the child's willingness to learn more while on the other side the lecture method otherwise called the conventional teaching method is only teacher centred and hence the students are not carried along, while results of hypothesis two was by Ogawa (2001) in Ohisen (2007), Sambo (2005) and Ogawa (2001) who all believed that Modern teaching methods in education are child-centred, the exact mandate of constructivism and that the most important nature of constructivist approach is interest, student-centred, activity-based, retentive and lead the students to have Mathematical power and the outcome of hypothesis three was supported by Atkins (2008), Mandrin & Preckel (2011) and Dean and Kuhu (2006) all corroborated this outcome by positing that when constructivist approaches are used to teach mathematics, the attitude of the students towards learning mathematics in the students is significantly increased . The students being the center point and the main active person in the constructivist approaches is always looking forward to improving in the subject, they develop positive attitude towards the learning and teaching of mathematics. While on the other hand they exhibit lesser fair attitude if the lecture method which is only teacher based is to be used in the teaching process. It was concluded that the use of constructivist approaches of Activity-Based, Guided-Discovery and Problem-Solving have significant positive effects on academic performance, retention and attitude of Junior Secondary Students in especially when compared with those taught with lecture teaching method. many recommendations were put forward that included the use of constructivist approaches should be encouraged among Mathematics teachers as it is very effective for improving students' attitude, academic performance and retention in Algebra in particular and Mathematics in general., as well as suggestions that Teachers of Mathematics should collaborate with publishers to publish Algebraic books written with the principles of constructivists teaching approaches and that Teachers, curriculum planners and stakeholders in Education should include samples of lesson note on how to teach Mathematics with constructivist approaches during Curriculum Reviewed, Workshops, Seminars, etc. Since the study main aim was to investigate the effects of constructivist approaches to teaching compared to the conventional approach on students' performance and retention in Algebra among Junior Secondary School Students in Okene Metropolis of Kogi State, Nigeria. it therefore gave out some suggestions for further studies such as extending more studies to other variables like gender, urban and rural areas, class size, etc. and also the need carry out on the effects of constructivist approaches on other branches of Mathematics like Geometry, Trigonometry, etc. The study was limited in many regards such as limiting it to only public secondary schools in Kogi State. Hence the findings may not necessarily be binding on private schools that covers algebra branch of Mathematics as well as limiting to only instruments of Algebraic Performance and Algebraic retention were objective tests. Therefore, it may not be effectively generalized for the findings.

5.2 Conclusion

From the analysis of the data and result of tested hypotheses, the research study wishes to conclude that the use of constructivist approaches of Activity-Based, Guided-Discovery and Problem-Solving have significant positive effects on academic performance, retention and attitude of Junior Secondary Students in especially when compared with those taught with lecture teaching method.

5.3 Recommendations

The following recommendations are put forward:

1. The use of constructivist approaches should be encouraged among Mathematics teachers as it is very effective for improving students' attitude, academic performance and retention in Algebra in particular and Mathematics in general.
2. Teachers of Mathematics should collaborate with publishers to publish Algebraic books written with the principles of constructivists teaching approaches.
3. Teachers, curriculum planners and stakeholders in Education should include samples of lesson note on how to teach Mathematics with constructivist approaches during Curriculum Reviewed, Workshops, Seminars, etc.

4. There is a need for paradigm shift form Teacher-centred to learners-centred teaching approaches in the teaching/learning of Algebra and Mathematics in general.

5.4 Suggestions for Further Studies

The study investigated the effects of constructivist approaches to teaching compared to the conventional approach on students' performance and retention in Algebra among Junior Secondary School Students in Okene Metropolis of Kogi State, Nigeria. Therefore, the following are suggested for further studies.

1. This study focussed attention on research variables like Attitude, Performance and Retention. Hence, it can be extended to other variables like gender, urban and rural areas, class size, etc.
2. This study only focussed attention on only Algebra. Further empirical studies can be carried out on the effects of constructivist approaches on other branches of Mathematics like Geometry, Trigonometry, etc.
3. The study was restricted to public Government Junior Secondary Schools in Okene Metropolis. Therefore, the study can be replicated in privately owned junior secondary institutions.

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APPENDIX A

Letter of Introduction

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January 04, 2021

Dear Sir/Madam,

LETTER OF INTRODUCTION: SALAWU ISAH SEZUO (200027253)

I write to introduce to you the bearer of this letter, Mr. Salawu Isah Sezuo, a postgraduate student in the University of Education, Winneba. He is reading for a Master of Philosophy degree in Mathematics Education and as part of the requirements of the programme, he is undertaking a research titled –***Effect of Constructivist Teaching Approaches On Junior Secondary School Students Performance, Retention And Attitude In Algebra***. He needs to gather information to be analysed for the said research and he has chosen to do so in your institution. I would be grateful if he is given the needed assistance to carry out this exercise. Thank you.

Yours faithfully,

Dr. Ali Mohammed
Graduate Coordinator

DEPARTMENT OF MATHEMATICS EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA

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APPENDIX B

Curriculum Matching Chart

TOPIC	CHAPTER TITLE	NERDC JSS2 CURRICULUM Themes and Topics	NERDC JSS2 Performance Objectives.
Preliminary	Review of previous course work	*Number and Numeration Algebraic Processes Geometry and Mensuration Everyday Statistics*	
1	Whole numbers	*Number and Numeration, pp 20, 21 topic 1: whole numbers and decimal numbers*	find prime factors of numbers < 200 indentify perfect squares find the LCM and HCF of numbers find the square roots of perfect squares.
2	Indices and standard form	*number and numeration, pp 20, 21 Topic1: whole numbers and decimal numbers*	Express whole number and decimal numbers in standard form Develop quantitative reasoning with standard form.
3	Quadrilaterals	*Geometry and Mensuration, p 27 Topic 1:Plane figures/shapes*	Define and recall the properties of parallelogram, rhombus and kite identify properties of quadrilaterals in the environment.
4	directed numbers: multiplication and division	*Numbers and numeration, p22 topic 5: multiplication and division of directed numbers*	Multiply and divide directed numbers
5	Inverse and identity	*Algebraic processes, pp23-26 all topics: enrichment underpinning*	Find Additive And Multiplicative Inverse Of Numbers Apply inverse operation to problem solving.
6	Angles in a polygon	*Geometry and Mensuration, p28 Topic2: Angles*	Find the sum of interior angles of convex polygon.
7	Expansion of algebraic expressions	*Algebraic processes, p23 topic1: algebraic expressions*	Expand algebraic expressions of the form a(b+c) and (a+b)(c+d)
8	Approximation and estimation	*Number and numeration, p22 topic 4: approximation*	Approximate number to given degree of accuracy apply quantitative reasoning approximation problems with fraction.
9	Fractions, proportion, ratio and rate	*Number and numeration, P21Topic 2: fractions*	Convert simple fraction to ratios decimal and percentages develop quantitative reasoning in problems with fractions
10	Arithmetic in home and office	*Number and numeration, p21 Topic 3: transaction in home and office*	Solve Arithmetic problems relating to home and office solve commercial arithmetic problems relating to profit, interest, discount and commissions
11	Algebra: Factors, factorization, fractions	*Algebraic processes, p23 Topic 1: Algebraic expressions*	Factorize simple algebraic expressions Simplify algebraic fractions
12	Graphs: Cartesian plane and coordinates	*Algebraic processes, p25 Tpic5: Graphs*	Identify × − and – y axis plot points on the Cartesian plane

TOPIC	CHAPTER TITLE	NERDC JS2 CURRICULUMThemes and Topics	NERDC JS2 Performance Objectives.
13 ➡	Solving equations	*Algebraic processes, p26 Topic 2 and 3: Simple equation: word problems*	Solve harder problems on simple equations interpret and solve word problems including algebraic fractions
14	Straight-line graphs	*Algebraic processes, p26 Topic 5: graphs*	Plot linear graphs from real life situations (e.g. prices/item, distance –time, velocity – time) interpret graphs and solve related quantitative reasoning problems
15	Using calculators and tables	*Number and numeration, p22 sub-topic 5: 1 square and square root tables*	Obtain the square and square root of numbers from tables use calculators appropriately
16	Scale drawing	*Geometry and mensuration, p27 Topic 1: plane figures /shapes*	Draw length and distances to scale Read and interpret scale drawings solve related quantitative reasoning problems
17	Pythagoras' rule	*Geometry and Mensuration Curriculum enrichment*	Use Pythagoras' rule to calculate sides in a right-angled triangles Apply Pythagoras' rule to real-life problems.
18	Tables, timetable and charts	*Number and numeration, p22 sub-topic 5, 2: Tables, chats and schedules Everyday Statistics, p29 Topic1: Data presentation*	Interpret and use tables, chats, schedules and records present and present social and environmental Data
19	Cylinders and cones	*Geometry and Mensuration Curriculum enrichment*	Calculate the surface areas and volumes of cylinders and cones
20	Angles of elevation and depression	*Geometry and mensuration, p28 Topic2: Angles*	Distinguish between angles of elevation and depression measure and apply angles of elevation and depression to find length and scale drawing
21	Probability	*Everyday statistics, p30 Topic 2: pro*	Find the experimental probability of events occurring Determine the probability of events happening everyday life Calculate probability as a fraction
22	Inequality	*Algebraic processes, p24-25 Topic 4: Linear inequalities*	Identify and solve linear inequality in one variable Represent solution of linear inequalities in one variable on the number line
23	Graphs of Linear equations	*Algebraic processes, p26 Topic 5:Graphs*	Draw graphs of linear equations in two variables
24	Bearings and distances	*Geometry and mensuration, p28 Topic2: Angles Curriculum enrichment*	State and find bearing of point from each other Construct Simple surveys and use scale drawing to find bearings and distances

APPENDIX C

Pre-Test

STUDENTS' ATTITUDNALQUESTIONNAIRE IN ALGEBRAIC CONCEPTS

This student's attitude questionnaire is meant to investigate students' attitude towards algebraic concept kindly read through each item. Below is a list of 60 items. You will find that you agree with some statements and disagree with others. Under each statement, five possible options are provided. Of the five options offered, select the one which represents your true feelings about the algebraic concepts in Mathematics as a subject in the Junior Secondary School curriculum. If you agree strongly with a statement place a tick (√) against the item that best corresponds to strongly agree (SA), agree (A), Undecided (U), Disagree (D), strongly Disagree (SD) your feelings about each question below. Cancel any decision you may wish to change and tick another one that you feel is appropriate. The questionnaire is not something to be graded and your answers are completely to be treated confidentially and anonymous.

Class: ______________________________

School: ______________________________

Sex: **Male (M)** ☐ **or** **Female (F)** ☐

SD=Strongly Disagree D=Disagree U=Undecided A=Agree SA=Strongly Agree

1.	Iam always undera terriblestrain in algebraclass.	SD	D	U	A	SA
2.	I do not likealgebra,andit scares meto haveto take it.					
3.	Algebra is veryinterestingto me,andIenjoy algebraic concepts.					
4.	Algebra is fascinatingand fun to do it is enjoyable.					
5.	Algebra makes mefeel secure,andat thesametimeit is stimulating to do.					
6.	Mymind goes blank,andIam unableto thinkclearly when workingalgebra.					
7.	I feel a senseofinsecurity when attempting algebra.					
8.	Algebra makes mefeel uncomfortable,restless, irritable,andimpatient.					
9.	My teachers used math games to reinforce my understanding of algebraic concepts.					
10.	Algebra makes mefeel as though I'm lost in a jungle ofnumbers					

	andcan't findmy wayout.					
11.	My mind goes blank and 1 am unable to think clearly when doing algebra.					
12.	When Ihearthewordalgebra,Ihavea feelingofdislike.					
13.	Iapproach algebra with a feelingofhesitation, resulting from a fearofnot beingableto do algebra					
14.	I reallylikealgebra topics.					
15.	Algebra is a coursein school which Ihavealways enjoyedstudying.					
16.	It makes menervous toeven thinkabout havingto do aalgebraproblem.					
17.	Ihaveneverlikedalgebra,andit is mymost dreadedsubject.					
18.	Iamhappierin aalgebraclass than in anyotherclass.					
19.	I feel at easein algebra class,andIlikeit verymuch.					
20.	I feel a definite positivereaction to algebra topics;it's enjoyable.					
21.	I have usually been at ease during algebra tests.					
22.	I struggled with many concepts in algebra.					
23.	My teachers relied on overhead projectors or chalkboards as tools to present information in algebra class.					
24.	My teachers spent the necessary amount of time and energy in helping me to understand algebraic concepts.					
25.	I do not want to teach algebra in the future.					
26.	I had many competent algebra teachers.					
27.	I have often helped others with their algebra homework.					
28.	My teachers emphasized understanding and not just memorization of algebraic concepts.					
29.	My teachers frequently used a lecture format in teaching algebra.					
30.	During my algebra classes I was expected to sit quietly and listen.					
31.	I usually comprehended algebraic contents well and seldom got lost.					
32.	I did not feel comfortable seeking help from my algebrateachers outside the class.					
33.	I did not like being introduced to new algebra content without practicebefore hand.					
34.	Algebra makes me feel uncomfortable and nervous when my is teaching.					
35.	I generally have had difficulty relating new algebraic concepts to those I had previously learned.					
36.	My teachers focused mainly on memorization of facts and procedures in algebra class.					
37.	My teachers were supportive in my efforts to learn algebraic concepts.					
38.	My algebra teachers assigned several homework problems each night.					

39.	1 has generally considered algebraic concepts as a related, sequential, progression of ideas.					
40.	My algebra teachers had confidence in me as a student of algebra.					
41.	I learned best when my algebra teachers took his time to connect new concepts to that which I had already learned.					
42.	I have usually been at ease during algebra classes and outside.					
43.	I chose major subjects that did not require too many algebraic contents.					
44.	I have taken algebra classes even though they were not required.					
45.	I have dropped algebra because they became too difficult.					
46.	I usually don't worry about my ability to solve algebra problems.					
47.	New algebraic content has usually been easy for me to understand.					
48.	I did not takealgebra classes in my senior year in high primary school.					
49.	It wouldn't bother me at all to learn more algebraic contents.					
50.	When confronted with a difficult algebra concept, I generally worked until I understood the concept.					
51.	I look forward to specialize in teaching algebra in higher institution.					
52.	I can't recall any algebraic concepts that were hard for me to understand.					
53.	My algebra teachers were very patient with me.					
54.	Many of my algebra teachers were incompetent.					
55.	My teachers did not believe I was capable of learning algebra.					
56.	When I had trouble with aalgebraic concept I usually gave up and stopped trying.					
57.	I get a sinking feeling when I think of trying hard algebra problems.					
58.	My algebra teachers often applied their lessons to real world situations.					
59.	Algebra makes me feel uneasy and confused when practicing.					
60.	1 was frequently lost and had trouble keeping up in my math classes.					

The adapted Fennema-Sherman instrument (1976)

APPENDIX D

Post-Test

STUDENTS' ATTITUDES QUESTIONNAIRE IN ALGEBRAIC CONCEPTS

This student attitude questionnaire is meant to investigate students' attitude towards algebraic concept kindly read through each item. Below is a list of 60 items. You will find that you agree with some statements and disagree with others. Under each statement, five possible options are provided. Of the five options offered, select the one which represents your true feelings about the algebraic concepts in Mathematics as a subject in the Junior Secondary School curriculum. If you agree strongly with a statement place a tick (√) against the item that best corresponds to strongly agree (SA), agree (A), Undecided (U), Disagree (D), strongly Disagree (SD) your feelings about each question below. Cancel any decision you may wish to change and tick another one that you feel is appropriate. The questionnaire is not something to be graded and your answers are completely to be treated confidentially and anonymous.

Class: ______________________________

School: ______________________________

Sex: Male (M) ☐ or Female (F) ☐

S/N	ITEMS	SA	A	U	D	SD
1	Algebra is an interesting area in mathematics to me					
2	Algebra is very important in everyday life activities					
3	I have never liked algebraic concept and it is my most dreaded area of mathematics					
4	I try to learn algebra because it helps to develop my mind and makes thinking more clearly					
5	Female students perform poorer than their male counterpart in algebra section in mathematics students at JSS III examination.					
6	I feel that mathematics teacher ignore me when I need more explanation in algebraic concepts.					

7	My mathematics teacher has been encouraging me to see that I comprehend more in algebraic concepts.					
8	I don't like algebraic concepts because the mathematics teacher does selective teaching always.					
9	I'm sure I can do better in algebra if our mathematics teacher solves more examples.					
10.	I don't think I could study mathematics at higher level.					
11.	I can do better in mathematics if I concentrate to learn more algebraic topics from my class mates.					
12.	Male are not naturally better in algebra than female counterpart in the class.					
13.	I'm good in mathematics more especially in algebra.					
14.	Algebra is worthwhile and necessary to my feature career.					
15.	I comprehend more in algebraic concepts when we were given group work in the class.					
16.	I don't do well in algebraic concepts when teacher grouped us to solve some problems.					
17.	If I'm not sure/know what to do on assignment given in algebra I don't try to do it at all.					
18.	If I find a given assignment difficult I always study more examples in order to try the given task.					
19.	I feel discouraged to tackle algebra problems that take long steps and longer time to solve.					
20.	I'm always interested to learn more algebraic concepts with teacher intervention or not.					
21.	I am happier in learning algebraic concept whether in class or at home.					
22.	I have never liked doing algebra because it makes feel					

	uneasy and confused.					
23.	I like solving problems in algebra because if the more I solved problems the more I understand and comprehend well.					
24	For students to pass Mathematics, they should develop a positive attitude towards the subject.					
25	Algebraic concepts involve performing mathematical operations with confidence, speed and accuracy.					
26	Algebraic concepts in Mathematics have greater application to life outside classroom than other subjects.					
27	I know I should be able to acquire knowledge and skills in algebra for further understanding of education and training.					
28	I know I should be able to utilize mathematical skills to enable me play a positive role in the development of a modern society.					
29	Learning Mathematics will enable me to be accurate in doing accounts in future.					
30	Passing Mathematics will enable me get a job in the Bank.					
31	Learning algebraic concepts will enable me to identify, symbolize and use mathematical relationships in everyday life.					
32	Learning algebraic concepts will enable me to communicate mathematical ideas effectively.					
33	Learning algebra will enable me to be numerate and orderly in mathematical thought.					
34	Algebraic concepts in Mathematics syllabus is too wide to be covered effectively.					
35	Mathematics is the greatest nightmare for students in our school.					
36	Algebraic topics should be allocated more time for effective teaching/learning in school.					
37	It does not make any difference to the mathematics students whether they are taught algebraic concepts or not.					
38	Learning algebraic concepts is the most important topic to JSS II students.					
39	Understanding Algebraic concepts does not necessarily require practice.					

40	It is easier to understand algebraic concepts than any other branches of mathematics.					
41	Algebraic Content set for the students should only relate to needs of the present but not abstract.					
42	Some of the topics in algebra should not be taught because they are not applicable anywhere after leaving school.					
43	Group work as a teaching/learning activity of algebra is not necessary for the caliber of students in our school since it is time consuming.					
44	Sometimes the Mathematics teacher invites a guest teacher to handle some of the algebraic topics students do not understand.					
45	Use of activity methods as well as project work makes algebra enjoyable in the teaching/ learning of mathematics.					
46	It is not possible to teach all topics in algebra using the same method.					
47	Too many assignments are given to us in algebra this made me not to like study mathematics.					
48	I do not like working in a group to solve algebraic problems because later some lazy students earn marks for nothing.					
49	We have all the learning materials and equipment we need in algebraic concepts lesson but no improvement in mathematics performance.					
50	Improvisation of teaching aids in algebra cannot be done because the teachers have a lot of work.					
51	Algebra cannot be learnt without the use of calculators and this makes it difficult since it very expensive to acquire.					
52	Peer teaching in algebra succeeds only with bright students.					
53	Continuous Assessment Tests in algebra should count forward to the student final grade in mathematics at JSS III.					
54	Emphasis on examination should not be done at the expense of students understanding of content in algebra.					
55	To enable faster syllabus coverage in algebra short tests should be done away with.					
56	The joint examination in Mathematics is a predictor of the students' final score in Junior Secondary School Certificate.					

57	Junior Secondary School Certificate leavers are unable to secure employment mainly because of the syllabus coverage and experience they got.					
58	Mathematics is a practical subject which should be tested regularly particularly algebraic concepts.					
59	I am aware that not many good courses and opportunities are available to Junior Secondary School Certificate leavers without performing well in Mathematics therefore I should work hard in the algebraic concepts.					
60	I will be great to win a prize in mathematics					

The adapted Fennema-Sherman instrument (1976)

APPENDIX E

Students' Algebraic Performance Test (APT)

PRE-TEST ITEMS

Class:________________________________ Time:_____________________________

School:______________________________

Gender: Male [ ] Female [ ]

INSTRUCTIONS: Attempt all questions. Each question is followed by five options. Solve and choose the correct answer for each question.

1. Expand the expression $5(3x-2y)$

   (a) $8x-7y$ (b) $15x-7y$ (c) $15x-10y$ (d) $8x-10y$ (e) $15x+10y$

2. Simplify the expression $(-3y)(x-2y)$

   (a) $3xy-6y^2$ (b) $3xy+5y^2$ (c) $6y^2-3xy$ (d) $-3xy-2y$ (e) $3xy+6y^2$

3. Expand $(x+2y)(7-x)$

   (a) $7x-x^2+14y-2xy$ (b) $7x+14y-x^2+2xy$ (c) $x^2=7x+14y-2xy$

   (d) $7x+2xy-14y+x^2$ (e) $7x+x^2-14y-2xy$

4. Solve the expression $(4y-3x)(3-2y+x)$

   (a) $12y+8y^2+10xy-9x+3x^2$ (b) $12y-8y^2-10xy+9x-3x^2$

   (c) $12y-8y^2+10xy-9x+3x^2$ (d) $12y-8y^2+10xy-9x-3x^2$

   (e) $12y+8y^2+10xy+9x-3x^2$

5. Factorize the expression $ax(m+n)+rx(m+n)$

   (a) $(m+n)(ax-rx)$ (b) $(m-n)(rx-ax)$ (c) $(m-n)(ax-rx)^2$

   (d) $(m+n)(rx-ax)$ (e) $(m+n)(ax+rx)$

6. Simplify the expression $3x(2x+1)-x(x-3)$

(a) $5x^2-6x$ (b) $5x^2+6x$ (c) $6x-5x^2$ (d) $-5x^2-6x$ (e) $-6x-5x^2$

7. The sum of four consecutive numbers is 58. Find the

(a) 13 (b) $14\frac{1}{2}$ (c) 26 (d) 15 (e) 27

8. Find the positive difference between 55 and the sum of 12 and 7.

(a) 29 (b) 74 (c) 39 (d) 36 (e) 26

9. Expand the expression $(4x+3)^2$

(a) $8x^2+36x+9$ (b) $16x^2+24x+9$ (c) $8x^2-36x-9$

(d) $18x^2+24x+9$ (e) $8x^2-34x-9$

10. The product of two numbers is 54. If one of the numbers is 27,find the other

(a) 3 (b) 21 (c) 17 (d) 10 (e) 11

11. Solve the equation $x-6=39-2x$

(a) 32 (b) 21 (c) 17 (d) 10 (e) 11

12. Simplify x if $15x-16=14$

(a) 2 (b) -2 (c) 4 (d) -4 (e) 3

13. Evaluate $\frac{6x^2+3y}{x+5y}$ if $x=3$ and $y=2$

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

14. The total age of a boy and his younger brother is 30 years. If the boy is 3 years older than his brother, how old is the younger brother?

(a) $15\frac{1}{2}$ (b) $14\frac{1}{2}$ (c) $13\frac{1}{2}$ (d) $16\frac{1}{2}$ (e) $17\frac{1}{2}$

15. Solve the equation $15x - 3 = 5x + 2$

(a) $2\frac{1}{2}$ (b) $3\frac{1}{2}$ (c) $1\frac{1}{2}$ (d) $4\frac{1}{2}$ (e) $\frac{1}{2}$ 16. Expand

16

the bracket $(x + y)^2$

(a) $x^2 + xy + y^2$ (b) $x^2 + 2xy + y^2$ (c) $x^2 + y^2 + y^2$

(d) $2x^2 + 2y^2 + y$ (e) $2x^2 + y^2 + 2y$

17. Simplify $(-8a) \times (-3a)$

(a) $24a^2$ (b) $-24a^2$ (c) $24a$ (d) $-11a^2$ (e) $11a^2$

18. Simplify $(3 - 5a)(-2a)$

(a) $6a^2 + 10a$ (b) $6a - 10a^2$ (c) $-6a^2 - 10a$ (d) $6a^2 - 10a$ (e) $10a^2 - 6a$

19. Expand and simplify $(2p - 3q)(5p - 4q)$

(a) $23p^2 + 20q^2 - 10pq$ (b) $10p^2 - 20q^2 - 23pq$ (c) $23p^2 - 20q^2 - 10pq$

(d) $10p^2 - 23pq + 12q^2$ (e) $23p^2 + 20q^2 + 10pq$

20. Expand and simplify $2(5x + 8y) + 3(2x - y)$

(a) $16x - 13y$ (b) $13x - 16y$ (c) $16x + 13y$ (d) $-16x - 13y$ (e) $-16x + 13y$

21. Express as a single fraction $\frac{3x+1}{3} + \frac{2x-1}{4}$

a) $\frac{4(4x+1)+3(2x-1)}{12}$ b) $\frac{4(4x+1)-3(2x-1)}{12}$

c) $\frac{4(4x-1)+3(2x-1)}{12}$ d) $\frac{4(4x+1)+3(1-2x)}{12}$

e) $\frac{4(4x+1)-3(1-2x)}{12}$

22. Solve the equation $\frac{13}{2x+1}=5$

(a) 0.2 (b) 0.8 (c) -0.8 (d) -0.2 (e) 0.5

23. Find the co-efficient of xy in the expansion of $(5x-2y)^2$

(a) 25 (b) 20 (c) -25 (d) -20 (e) 4

24. Factorize the expression x^2-16

(a) $(x+4)(x+4)$ (b) $(x-4)(x-4)$ (c) $(x-3)(x-4)$

(d) $(x+4)(x+3)$ (e) $(x+4)(x-4)$

25. Factorize x^2-4x+3

(a) $(x+3)(x-1)$ (b) $(x+3)(x+1)$

(c) $(x-3)(x-1)$ (d) $(x-3)(x+1)$ (e) $(x-3)(x+2)$

26. The sum of four times a certain number and 27 is 89. Find the number.

(a) 18 (b) 28 (c) 14 (d) 16

27. Factorize the expression x^2-4x+3

(a) $(x+3)(x-1)$ (b) $(x-3)(x+1)$ (c) $(x-3)(x-1)$ (d) $(x+3)(x+1)$

28. Expand $(2a+3d)^2$

(a) $4a^2-12ad+9d^2$ (b) $4a^2-12ad-9d^2$ (c) $4a^2+12ad+9d^2$

(d) $4a^2-9d^2+25$

29. Solve the equation $\frac{2(4x-1)}{3}=\frac{9(x+1)}{4}$

(a) 14 (b) 7 (c) 9 (d) 18

30. Solve the expression $a^2 - b^2$

(a) $(a+b)(a+b)$ (b) $(a-b)(a-b)$ (c) $(b-a)(b-a)$ (d) $(a-b)(a+b)$

31. Simplify as far as possible $\frac{7x-14}{10} - \frac{2x+1}{10}$

a. $\frac{x+3}{2}$ b. $\frac{x+3}{5}$ c. $\frac{x-3}{2}$ d. $\frac{x-3}{5}$

32. A father is 40 years older than his son. In a year's time he will be five times as old as the son. How old is the son.

a. 9 b. 8 c. 10 d. 7

33. The result of adding to five times a number is the same as adding 20 to twice the number. Find the number.

a. 10 b. 12 c. 9 d. 6

34. Solve the equation $\frac{7}{x-2} = \frac{5}{x}$

a. 5 b. -5 c. 10 d. -10

35. Solve the equation $\frac{4}{w+3} - \frac{3}{w-2}$

a. 1 b. 2 c. -1 d. -2

36. Solve the equation $3x - 7 = 5x - 6$

(a) $-\frac{1}{2}$ (b) $\frac{1}{2}$ (c) $1\frac{1}{3}$ (d) $\frac{1}{3}$

37. Simplify the expression $4(2y-3x) - 3(3y-x)$

(a) $9x - y$ (b) $y - 9x$ (c) $-y - 9x$ (d) $y + 9x$

38. Expand $(3x-5)^2$

(a) $9x^2 + 30x - 25$ (b) $9x^2 - 30x + 25$ (c) $9x^2 - 30x - 25$ (d) $9x^2 + 30x + 25$

39. Solve $\frac{2y+7}{6} + \frac{y-5}{3} = 0$

a. $\frac{1}{4}$ b. $\frac{2}{3}$ c. $\frac{3}{4}$ d. $\frac{1}{3}$

40. The sum of three consecutive natural numbers is 72. Find the three numbers.

a. 26 b. 23 c. 24 d. 25

MARKING SCHEME TO PRETEST APPENDIX D (2.5 MARKS EACH)

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

APPENDIX F

Students' Algebraic Performance Test (APT)

POST-TEST ITEMS

Class:_________________________ Time:______________

School:________________________

Gender: Male [ ] Female [ ]

Instructions: Attempt all the questions. Each question is followed by four options. Choose the correct answer for each question.

1. The expression $(x+3y)(2x+5y)$ and find the coefficient of xy

 (a) 6 Expand (b) 15 (c) 5 (d) 11

2. Solve the equation $3x-7=5x-6$

 (b) $-\frac{1}{2}$ (b) $\frac{1}{2}$ (c) $1\frac{1}{3}$ (d) $\frac{1}{3}$

3. Simplify the expression $4(2y-3x)-3(3y-x)$

 38. $9x-y$ (b) $y-9x$ (c) $-y-9x$ (d) $y+9x$

4. Expand $(3x-5)^2$

 (b) $9x^2+30x-25$ (b) $9x^2-30x+25$ (c) $9x^2-30x-25$

 (d) $9x^2+30x+25$

5. Factorize x^2-121

 (a) $(x+11)(x-11)$ (b) $(x-11)(x-11)$ (c) $(x+11)(x+11)$ (d) $(x-121)$

6. The sum of twice a certain number and 26 is 72. Find the number.

 (a) 26 (b) 46 (c) 23 (d) 98

7. Solve the equation $\frac{7x-2}{3}=\frac{x}{5}$

 (a) $\frac{1}{16}$ (b) $\frac{5}{16}$ (c) $\frac{3}{16}$ (d) $\frac{7}{16}$

8. Solve the equation $p+14=29-2p$

(a) 3 (b) 10 (c) 15 (d) 5

9. The sum of four times a certain number and 27 is 89. Find the number.

(a) 18 (b) 28 (c) 14 (d) 16

10. Factorize the expression $x^2 - 4x + 3$

(a) $(x+3)(x-1)$ (b) $(x-3)(x+1)$ (c) $(x-3)(x-1)$ (d) $(x+3)(x+1)$

11. Expand $(2a+3d)^2$

(a) $4a^2 - 12ad + 9d^2$ (b) $4a^2 - 12ad - 9d^2$ (c) $4a^2 + 12ad + 9d^2$

(d) $4a^2 - 9d^2 + 25$

12. Solve the equation $\frac{2(4x-1)}{3} = \frac{9(x+1)}{4}$

(a) 14 (b) 7 (c) 9 (d) 18

13. Solve the expression $a^2 - b^2$

(a) $(a+b)(a+b)$ (b) $(a-b)(a-b)$ (c) $(b-a)(b-a)$ (d) $(a-b)(a+b)$

14. Solve $\frac{1}{y} + \frac{1}{5} = \frac{1}{3}$

(a) $7\frac{1}{2}$ (b). $8\frac{1}{2}$ (c) $10\frac{1}{2}$ (d) $9\frac{1}{2}$

15. Solve $2\frac{3}{4} + \frac{33}{2x} = 0$

(a) 6 (b) 8 (c) -6 (d) -8

16. Simplify $\frac{x-2}{6} - \frac{x-7}{4}$

(a) $\frac{25-x}{12}$ (b) $\frac{-x+17}{12}$ (c) $\frac{-(25+x)}{12}$ (d) $\frac{17-x}{12}$

17. Simplify $\frac{x+3}{6} + \frac{2x-1}{3}$

(a) $\frac{5x+1}{6}$ (b) $\frac{3x+2}{6}$ (c) $\frac{5x-1}{6}$ (d) $\frac{3x-2}{6}$

18. The difference between five times a number and twelve is 48. Find the number.

(a) 48 (b) 12 (c) 5 (d) 60

19. Simplify the expression $\frac{15a}{16} - \frac{3a}{18}$

(a) $\frac{12a}{8}$ (b) $\frac{12a}{16}$ (c) $\frac{9a}{12}$ (d) $\frac{18a}{24}$

20. Expand the expression $(2-a)^2$

(a) a^2+4a+4 (b) a^2+4a-4 (c) a^2-4a-4 (d) $4-4a+a^2$

21. Factorize the expression $cx+cy+2dx+2dy$

(a) $(x-y)(c-2d)$ (b) $(x+y)(c-2d)$
(c) $(x+y)(c+2d)$ (d) $(x-y)(c+2d)$

22. Factorize the expression $(2u-3v)(3m-4n)-(2u-3v)(m+2n)$

(a) $2(2u+3v)(m+3n)$ (b) $2(2u-3v)(m-3n)$ (c) $2(2u-3v)(m+3n)$

(d) $2(2u+3v)(m-3n)$

23. Simplify $2a-[4a-(5a-7)]$

(a) $3a-7$ (b) $3a+7$ (c) $7-3a$ (d) $-(7+3a)$

24. I think of a number. I take away 14. The result is 13. What number am I thinking of?

(a) 28 (b) 26 (c) 25 (d) 27

25. I think of a number. Multiply it by 7. I add 12. The result is 40. What is the number?

(a) 5 (b) 14 (c) 4 (d) 12

26. Simplify the expression $\frac{6h+5}{7} - \frac{4h-6}{21}$

a. $\frac{2h+3}{3}$ b. $\frac{3h+2}{3}$ c. $\frac{3-2h}{3}$ d. $\frac{2-3h}{3}$

27. I add 55 to a certain number and then divide the sum by 3. The result is four times the first number. Find the original umber.

a. 15 b. 5 c. 10 d. 11

28. A mother is 24 years older than her daughter. If the daughter's age is x years, find the x when the daughter's age is one-third of her mother's age.

a. 24 b. 6 c. 12 d. 8

29. I add 45 to a certain number and then divide the sum by 2. The result is five times the original number. Find the number.

a. 8 b. 7 c. 10 d. 5

30 I subtract 3 from a certain number, multiply the result by 5 and then add 9. If the final result is 54, find the original number.

a. 17 b. 14 c. 15 d. 12

31. Simplify as far as possible $\frac{7x-14}{10} - \frac{2x+1}{10}$

a. $\frac{x+3}{2}$ b. $\frac{x+3}{5}$ c. $\frac{x-3}{2}$ d. $\frac{x-3}{5}$

32. A father is 40 years older than his son. In a year's time he will be five times as old as the son. How old is the son.

a. 9 b. 8 c. 10 d. 7

33. The result of adding to five times a number is the same as adding 20 to twice the number. Find the number.

a. 10 b. 12 c. 9 d. 6

34. Solve the equation $\frac{7}{x-2} = \frac{5}{x}$

a. 5 b. -5 c. 10 d. -10

35. Solve the equation $\frac{4}{w+3} - \frac{3}{w-2}$

a. 1 b. 2 c. -1 d. -2

36. I think of number. I take away 14 and the result is 26. What number am I thinking of ?

a. 48 b. 12 c. 36 d. 40

37. Expand $(2a+b)^2$

a. $4a + 2ab^2 + b^2$ b. $4a^2 + 4ab + b^2$ c. $4a^2 + 2ab + b^2$ d. $4a + 2ab + b^2$

38. I add 45 to a certain number and then divide the sum by 2. The result is five times the original number. Find the number.

a. 5 b. 7 c. 10 d. 8

9. Solve $\frac{2y+7}{6}+\frac{y-5}{3}=0$

a. $\frac{1}{4}$ b. $\frac{2}{3}$ c. $\frac{3}{4}$ d. $\frac{1}{3}$

40. The sum of three consecutive natural numbers is 72. Find the three numbers.

a. 26 b. 23 c. 24 d. 25

MARKING SCHEME TO POST-TEST APPENDIX E (2.5 MARK EACH)

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

APPENDIX G

Algebraic Performance Test (APT) on Students' Retention

POST POST-TEST ITEMS

Class:________________________ Time:______________

School:________________________

Gender: Male [ ] Female [ ]

Instructions: Attempt all the questions. Each question is followed by four options. Choose the correct answer for each question.

1. Simplify as far as possible $\frac{7x-14}{10} - \frac{2x+1}{10}$

   $a.\ \frac{x+3}{2}$ $b.\ \frac{x+3}{5}$ $c.\ \frac{x-3}{2}$ $d.\ \frac{x-3}{5}$

2. A father is 40 years older than his son. In a year's time he will be five times as old as the son. How old is the son.

   a. 9 b. 8 c. 10 d. 7

3. The result of adding to five times a number is the same as adding 20 to twice the number. Find the number.

   a. 10 b. 12 c. 9 d. 6

4. Solve the equation $\frac{7}{x-2} = \frac{5}{x}$

   a. 5 b. -5 c. 10 d. -10

5. Solve the equation $\frac{4}{w+3} - \frac{3}{w-2}$

   a. 1 b. 2 c. -1 d. -2

6. Factorize the expression $cx + cy + 2dx + 2dy$

(a) $(x-y)(c-2d)$ (b) $(x+y)(c-2d)$ (c) $(x+y)(c+2d)$

(d) $(x-y)(c+2d)$

7. Factorize the expression $(2u-3v)(3m-4n)-(2u-3v)(m+2n)$

(a) $2(2u+3v)(m+3n)$ (b) $2(2u-3v)(m-3n)$ (c) $2(2u-3v)(m+3n)$

(d) $2(2u+3v)(m-3n)$

8. Simplify $2a-[4a-(5a-7)]$

(a) $3a-7$ (b) $3a+7$ (c) $7-3a$ (d) $-(7+3a)$

9. I think of a number. I take away 14. The result is 13. What number am I thinking of?

(a) 28 (b) 26 (c) 25 (d) 27

10. I think of a number. Multiply it by 7. I add 12. The result is 40. What is the number?

(a) 5 (b) 14 (c) 4 (d) 12

11. The expression $(x+3y)(2x+5y)$ and find the coefficient of xy

(a) 6 (b) 15 (c) 5 (d) 11

12. Solve the equation $3x-7=5x-6$

(c) $-\frac{1}{2}$ (b) $\frac{1}{2}$ (c) $1\frac{1}{3}$ (d) $\frac{1}{3}$

13. Simplify the expression $4(2y-3x)-3(3y-x)$

39. $9x-y$ (b) $y-9x$ (c) $-y-9x$ (d) $y+9x$

14. Expand $(3x-5)^2$

(c) $9x^2+30x-25$ (b) $9x^2-30x+25$ (c) $9x^2-30x-25$

(d) $9x^2+30x+25$

15. Factorize x^2-121

(a) $(x+11)(x-11)$ (b) $(x-11)(x-11)$ (c) $(x+11)(x+11)$ (d) $(x-121)$

16. The sum of twice a certain number and 26 is 72. Find the number.

(a) 26 (b) 46 (c) 23 (d) 98

17. Solve the equation $\frac{7x-2}{3}=\frac{x}{5}$

(a) $\frac{1}{16}$ (b) $\frac{5}{16}$ (c) $\frac{3}{16}$ (d) $\frac{7}{16}$

18. Solve the equation $p+14=29-2p$

(a) 3 (b) 10 (c) 15 (d) 5

19. The sum of four times a certain number and 27 is 89. Find the number.

(a) 18 (b) 28 (c) 14 (d) 16

20. Factorize the expression x^2-4x+3

(a) $(x+3)(x-1)$ (b) $(x-3)(x+1)$ (c) $(x-3)(x-1)$ (d) $(x+3)(x+1)$

21. Expand $(2a+3d)^2$

(a) $4a^2-12ad+9d^2$ (b) $4a^2-12ad-9d^2$ (c) $4a^2+12ad+9d^2$

(d) $4a^2-9d^2+25$

22. Solve the equation $\frac{2(4x-1)}{3}=\frac{9(x+1)}{4}$

(a) 14 (b) 7 (c) 9 (d) 18

23. Solve the expression a^2-b^2

(a) $(a+b)(a+b)$ (b) $(a-b)(a-b)$ (c) $(b-a)(b-a)$ (d) $(a-b)(a+b)$

24. Solve $\frac{1}{y}+\frac{1}{5}=\frac{1}{3}$

(a) $7\frac{1}{2}$ (b) $8\frac{1}{2}$ (c) $10\frac{1}{2}$ (d) $9\frac{1}{2}$

25. Solve $2\frac{3}{4}+\frac{33}{2x}=0$

(a) 6 (b) 8 (c) -6 (d) -8

26. Simplify $\frac{x-2}{6} - \frac{x-7}{4}$

(a) $\frac{25-x}{12}$ (b) $\frac{-x+17}{12}$ (c) $\frac{-(25+x)}{12}$ (d) $\frac{17-x}{12}$

27. Simplify $\frac{x+3}{6} + \frac{2x-1}{3}$

(a) $\frac{5x+1}{6}$ (b) $\frac{3x+2}{6}$ (c) $\frac{5x-1}{6}$ (d) $\frac{3x-2}{6}$

28. The difference between five times a number and twelve is 48. Find the number.

(a) 48 (b) 12 (c) 5 (d) 60

29. Simplify the expression $\frac{15a}{16} - \frac{3a}{18}$

(a) $\frac{12a}{8}$ (b) $\frac{12a}{16}$ (c) $\frac{9a}{12}$ (d) $\frac{18a}{24}$

30. Expand the expression $(2-a)^2$

(a) $a^2 + 4a + 4$ (b) $a^2 + 4a - 4$ (c) $a^2 - 4a - 4$ (d) $4 - 4a + a^2$

31. Simplify the expression $\frac{6h+5}{7} - \frac{4h-6}{21}$

a. $\frac{2h+3}{3}$

b. $\frac{3h+2}{3}$

c. $\frac{3-2h}{3}$

d. $\frac{2-3h}{3}$

32. I add 55 to a certain number and then divide the sum by 3. The result is four times the first number. Find the original umber.

a. 15 b. 5 c. 10 d. 11

33. A mother is 24 years older than her daughter. If the daughter's age is x years, find the x when the daughter's age is one-third of her mother's age.

a. 24 b. 6 c. 12 d. 8

34. I add 45 to a certain number and then divide the sum by 2. The result is five times the original number. Find the number.

a. 8 b. 7 c. 10 d. 5

35. I subtract 3 from a certain number, multiply the result by 5 and then add 9. If the final result is 54, find the original number.

a. 17 b. 14 c. 15 d. 12

36. Solve $\frac{3(2a+1)}{4} = \frac{5(a+5)}{6}$

a. 4.5 b. 7.5 c. 3.5 d. 6.5

37. Solve $\frac{4t+3}{5} = \frac{t+3}{2}$

a. 4 b. 6 c. 3 d. 5

38. Solve $\frac{3x}{7} = \frac{2x}{3} - \frac{1}{3}$

$a.1\frac{1}{5}$ $b.1\frac{4}{5}$ $c.1\frac{3}{5}$ $d.1\frac{2}{5}$

39. Solve $\frac{3m}{5} - \frac{m}{3} = \frac{8}{5}$

a. 3 b. 6 c. 5 d. 2

40. Solve $5(x+11)+2(2x-5)=0$

a. -7 b. -3 c. -6 d. -5

MARKING SCHEME TO APPENDIX F (2.5 MARKS EACH)

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

APPENDIX H

Activity-Based Lesson Plan for Experimental Group

LESSON ONE

Date:	11th January, 2021
Week:	Two
Subject:	Mathematics
Topic:	Algebra
Sub-topic:	Expansion of Algebraic Expression
Class:	JSS II
Average Age:	13 years
Duration:	40mins
Methodology:	Activity Based Approach
Behavioural Objectives:	By the end of the lesson students should be able to:
	(i) Expand algebraic fractions
	(ii) Simplify the like terms

Previous Knowledge: Students are familiar with simplification of common fractions

Instructional materials:	Pencil, Biro, Worksheet
Reference materials:	New General Mathematics for Junior Secondary Schools
Rational:	The knowledge of algebraic fraction is very important to other science and engineering students in their previous lower classes were already familiar on how to solve fraction without variables attached. It is therefore very important for students to see further application of fraction with given algebraic fractions

LESSON DEVELOPMENT ON EXPANSION OF ALGEBRAIC FRACTIONS

Stage	Teachers Activity	Learners Activity	Learning Point
Introduction (5 mins)	Teacher group the students and give them problem on previous knowledge. The teacher goes round the groups and sees what they are doing. Later ask each group to present their findings. Example (i) simplify the expression $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ (ii) solve $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$	Learners carrying out the activity as instructed by the teacher <u>Expected solution</u> example (i) $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ using BODMAS $\frac{1}{2}\times\frac{3}{7}=\frac{3}{14}$ add $\frac{2}{7}$ to the above $\frac{3}{14}+\frac{2}{7}=\frac{3+4}{14}$ $=\frac{7}{14}-\frac{1}{7}=\frac{7-2}{14}$ $=\frac{5}{14}$ Example (ii) $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$ $=\frac{5}{28}+\frac{1}{6}=\frac{30+28}{148}$ $=\frac{58}{148}=\frac{29}{74}$	Learners to recall on the rule of BODMAS and it application to problems on simple fractions
Presentation	Teacher shares the learning materials to each group. The	Learners carry out activity such as instructed by the	(i) Leadership achieved (ii) Identification

Step I:	presents the lesson by describing to students on how to expand algebraic expression such as: example 1 Expand the expression $5(3x-2)+3(2x+6)$ first multiply and open the bracket term by term and collect like term	teacher. Expected answers 1 $5(3x-2)+3(2x+6)$ $=15x-10+6x+18$ Collect like terms $15x+6x+18-10$ $=21x+8$	of learning materials (iii) Ability to follow instructions to solve problems (iv) Self learning
Step II	Teacher gives the students activities to perform in their various groups	Task1: Expected result Expand $(2a+b)^2$ Expected answer: $(2a+b)^2=$ $(2a+b)(2a+b)$ after interpreting as above $(2a+b)^2$ $=(2a+b)(2a+b)$ Expand the brackets by multiplying and then collect the like terms and perform the necessary operation. $(2a+b)(2a+b)$ = $4a+2ab+2ab+b^2$	Students follow the given instructions to solve the task. First they discuss on how to go by the problem and agree before they put down their resolution on the activities given. They achieve on how to work in groups and members are able to participate actively

		$= 4a^2 + 4ab + b^2$	
Step III	The teacher asks each group leader to report their findings so as to compare the result they obtained. Teacher evaluates the lesson by asking questions from the students to solve the following on their own in their note book Exercise 1: Expand $(3x+7)^2$ Exercise 2: Expand $5(3x+2)+(4x-1)^2$	All students are solving the given problems on their own without assistance from their classmate <u>Expected answer</u> Ex.1 expand $(3x+7)^2$ is interpreted as below $(3x+7)^2 =$ $(3x+7)(3x+7)$ Now multiply as follow $(3x+7)(3x+7) =$ $9x^2 + 21x + 21x + 49$ Collect like terms $9x^2 + 42x + 49$ <u>Expected answer 2</u> Expand $5(3x+2)+(4x-1)^2$ $15x + 10 + 16x^2 - 8x + 1$ Collect the like terms as:	Ability to compare their work and see the area of their challenge. Each student is able to work independently without assistance and those who had difficulty along the line are able to discover their mistakes and learn how to solve problems

		$16x^2 + 15x - 8x + 10 + 1$ $= 16x^2 + 7x + 11$	
Conclusion	The teacher re-explains to the students on solving the problems given to the students. He collects their note books and mark them	Learners compare their work with the teacher's corrections made on the board	Compare their work with the teacher and also they now know how many they got correctly
Home work	The teacher gives the following problems to students as home work. Task 1: expand $(2a-7)^2$ task 2: expand $(5b+3)^2$ task 3: expand $3(2a-6) \quad +5(6a+3)$	Learners form the habit to revise what they have done in the school at home	Habit of reading and self study achieved

ACTIVITY-BASED LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON TWO

Date:	18^{th} January, 2021
Week:	Two
Subject:	Mathematics
Topic:	Algebra
Sub-topic:	Expansion of Algebraic Expression
Class:	JSS II
Average Age:	13 years
Duration:	40mins
No. Of students:	
Methodology:	Activity Based Approach
Behavioural Objectives:	By the end of the lesson students should be able to:

(i) Practically construct using cardboard sheet $p(a+b) = ap + bp$

(ii) Practically construct using cardboard sheet $(a+b)^2 = (a+b)(a+b) = a^2 + 2ab + b^2$

(iii) Practically construct with aid $(a-b)(a-b) = ac - ad - bc + bd$

Previous Knowledge: (i) Students are familiar with simplification of Algebraic Equations like $a(a+b) = a^2 + ab$ without illustration in a diagram.

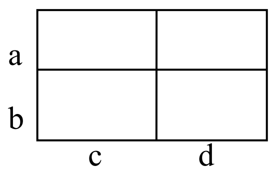
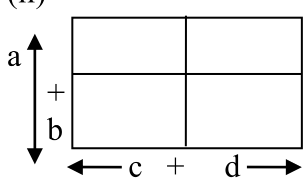
(ii) Find areas of rectangle, square using practical method

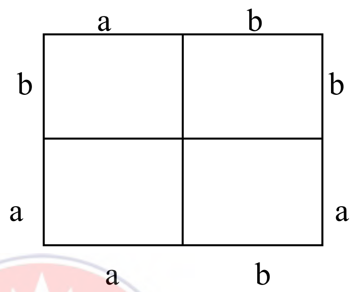
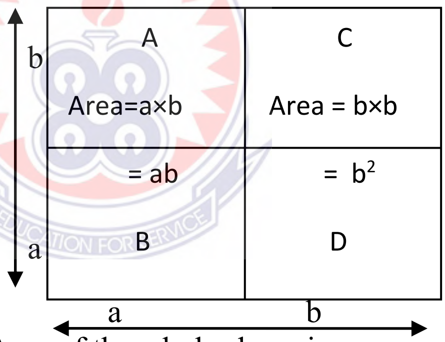
Instructional materials: cardboard sheets, pair of scissors, pencils, biro

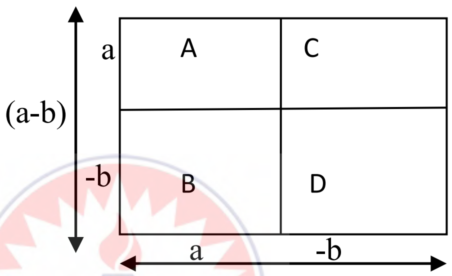
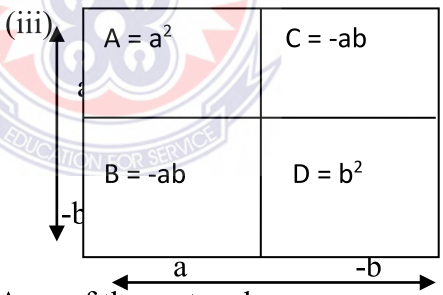
Reference materials: National Mathematical Centre Teaching Module for JS 2

Rational: The knowledge of algebraic expansion is essential to engineering and other sciences. Also the expression of some algebraic into diagrams to obtain solution aid the students motivation and academic performance

LESSON DEVELOPMENT ON ALGEBRAIC DIAGRAMATICALY

Stage	**Teachers Activity**	**Learners Activity**	**Learning Point**
Introduction	Teacher group the students and give them problems on previous knowledge. The teacher gives the students task to solve base on the their previous knowledge Example 1 Expand the expression $5(3x-2)+4(2x-1)$	Expected answers to example 1 $5(3x-2)+4(2x-1)$ The learners carry out the activity as instructed by the teacher. Expand $5(3x-2)+4(2x-1)$ $= 15x-10+8x-4$ $= 23x-14$	Learners to recall on the previous knowledge problem solved. Work in group as directed by the teacher
Presentation Step I	The teacher shares the learning materials to each group and presents the first task to the students. Example 1: expand expression of the form $(a+b)(c+d)$ With the aid of diagram Guide the students to construct a rectangle of length $(a+b)$ And width (c + d)	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a,b,c,d (ii) label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii) find the area of the shape <u>Expected answer</u> (i)  (ii)  (iii) Area of the rectangle as given by the shape $(a+b)^2 = (a+b)\times(c+d)$	(i) Learners develop the ability to follow instructions. (ii) Develops learners' higher order thinking skill. (iii) Develop learners to see the relationship between the formula Area =length ×breadth As related to this rectangular shape. (iv) Working in groups become more meaningful to

		$(a+b)^2 = (a+b)(c+d)$ $= a(c+d)+b(c+d)$ $= ac+ad+bc+bd$	the learners because they enjoyed working together
Step II	The teacher gives the following problems to the groups to try them in their groups using the diagram to illustrate them and solve Task 1 (i)expand the expression of the form $(a+b)^2$ (ii)using diagram to find the area occupied by the above expression	Students appoint their leaders of each of the group to coordinate them. Students carry out the task given. First re-express $(a+b)^2 = (a+b)(a+b)$ on the diagram as below . leaners' partition a rectangle into four parts   Area of the whole shape is area $=(a+b)\times(a+b)$ $= a^2 + ab + ab + b^2$ $= a^2 + 2ab + b^2$ OR Sum up Area = (A + B + C + D) becomes Area(A +B +C +D) = $ab + a^2 + ab + b^2$ collect the like terms we have Area = $a^2 + 2ab + b^2$ Thus $(a+b)^2 = a^2 + 2ab + b^2$	(i) Leadership training achieved by the learners (ii) Recalling and follow the right step achieved (iii) Ownership of the knowledge for successful proving (iv) Ability to follow instruction to solve problems (v) Self learning confident developed

Step III	The teacher gives the students activities to perform in their groups Task 1 (i)expand the expression $(a-b)^2$ using diagram (ii)draw rectangle and divide it into four equal parts (iii)label the diagram a,-b,a,-b on each ssquarevshape (iv)find the area of the shape and otherwise the alternative method. The teacher moves round to guide the students while carry on the activities in each group	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a, b, c,d (ii)label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii)find the area of the shape <u>Expected answer</u> The learners draw the rectangle and partition it into four parts as below and label them as side a, -b, a, -b.   Area of the rectangle Area = A + B+ C +D = a^2 + (-ab)+ (-ab) + b^2 = $a^2 - 2ab + b^2$ Alternative method Area =$(a-b)^2$ = (a-b)(a-b) Multiply the two brackets and gets (a-b)(a-b) = a^2 -ab -ab + b^2 = $a^2 - 2ab + b^2$	(i) Students follow the instructions they discussed and resolved. (ii) All members participate in the activity. (iii) They present their findings and compare their work with other groups

Step iv	The teacher asks each group to present Their findings	They all participate in solving the problems following the given instructions.	(i) Ability to work in groups (ii) Every student participates full in the given tasks. (iii) The leader of each group presents their findings. (iv) Learners are able to compare their findings with other groups. (v) They are able to overcome their challenges if any difference exists.
Conclusion	The teacher now wrap up the lesson by given emphasis to where they have differences in order to overcome their challenges	The students are able to notice if any difference exist and how to overcome it.	

ACTIVITY-BASED LESSON PLAN FOR EXPERIMENTAL GROUP
LESSON THREE

Date:	25^{th} January, 2021
Subject:	Mathematics
Class:	SS II
Average Age;	13 years
Duration:	40 mins
Gender:	Male and Female
Topic:	Algebraic Equations
Sub-topic:	Word Problems
Instructional materials:	Biro, Pen, Pencil, Ruler, Worksheet, New General Mathematics for JSS Two
Behavioural Objectives:	By the end of the lesson the students should be able to: (i) Translate word problems leading to linear equations. (ii) Solve the equations correctly.

Previous Knowledge: The students have been taught on how to solve linear equations

LESSON DEVELOPMENT ON WORD PROBLEMS

Stage	Teacher's Activity	Learner's Activity	Learning Points
Introduction	Teacher group the students and give them problems on previous knowledge to solve. The teacher goes round to see what each student is doing. Later he asks some of them from all the groups to present their findings. Exercise 1: Solve the equation $6x+5=23$ Exercise 2 Find the value of y in the equation $9-3y=27$	Learners carry out the activity as required <u>Expected Answers</u> solution 1 $6x+5=23$ Subtract 5 from both sides we get $6x+5-5=23-5$ $6x=18$ Divide both sides by 6 we get $\frac{6x}{6}=\frac{18}{6}$ $x=3$ Solution 2 $9-3y=27$ Subtract 9 from both sides we get $9-9-3y=27-9$ $-3y=18$ Divide both side by sides minus 3 (-3) $\frac{-3y}{-3}=\frac{18}{-3}$ $y=-6$	(i)Recall of previous lesson (ii)utilization of the previous lesson and connection (iii)Achieved the ability to manipulate the unwanted variables to a particular side he wants it to be without losing the value. (iv)how to collect the like terms (v)using the correct coefficient to have the value of the variable achieved.
Presentation Step I	The teacher shares the learning materials and work	Expected solution 1 Let the brothers age be (x+4), x the senior	Learners tryout the problem by collaboration to

	sheet to the learners in each group. The teacher presents the lesson on word problems on linear equations to students as examples and he involve the learners at every stage by first give room to students to participate at each level before he demonstrate or solve the problem. Each group should not more than five students Example 1 The sum of ages of two brothers is 18 years. If one is 4 years older than the other, find the ages of the two brothers. Learners use the worksheet and the teacher moves round the groups to see how the task and guide any group(s) who finds the problem difficult to solve by putting them on the way for them to continue	be (x+4) the junior be x. Thus $x+(x+4)=18$ Open the bracket $x+x+4=18$ Collect like terms $2x+4=18$ Subtract 4 from both side we have: $2x+4-4=18-4$ $2x=14$ Divide both sides by 2 $\frac{2x}{2}=\frac{14}{2}$ $x=7years$, if $x=7\,junior$ Then x+4 for senior 7+4 = 11 years $\therefore senior=11years$ $junior=7years$	arrive at the correct answer slow learners able to understand how to solve the problem through the explanation given by one of them who got it correctly. They become ownership of the lesson when the teacher approved their answers
Step II	Teacher gives the students the following activities	<u>Expected answer 1</u> Let x represent the	(i)learners become consolidated of the new concepts (word

	to in their various groups Exercise 1 Suppose the sum of the ages of two students is 22years.if one of the students is 2 years older than the other, find the ages of the two students. Exercise 2 The difference between five times a number and twelve is 48.find the number	age of the first student x+2 represent the age of the second student total age = 22years thus, the sum of their ages are $x+(x+2)=22$ Open the bracket $x+x+2=22$ Collect like terms 2x+2 = 22 Subtract 2 from both sides 2x+2-2 =22-2 2x = 20 Divide both sides by 2 $\frac{2x}{2}=\frac{20}{2}$ x = 10 years and x+ 2 becomes 10 + 2 = 12 years $\therefore$ their ages are x = 10, x = 12 expected answer 2 let x be the number 5 times a number is 5x Now 5x -12 = 48	problem) in linear equation (ii)ownership of the basic principles of solving word problems in linear equations

		Add plus 12 (+12) to both sides we have: 5x-12+12 = 48 +12 5x = 60 Divide both sides by 5 $\frac{5x}{5} = \frac{60}{5}$ x = 12	
Step III	The teacher asks each group leader to present their findings	The learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging area	(i)discovery of faulty steps taken for the group who had difficulty (ii)conscientious agreement achieved
Evaluation	Teacher evaluates the lesson by given the following problems for the learners as class work to be solved individually. teacher moves round to see what each of them is doing Exercise 1 I think of number. I take away 14 and the result is 26. What number am I	Expected answer 1 Let the number be x If x is the number -14 i.e x -14 = 26 add 14 to both sides x -14+ 14 = 26 +14 x = 40 Expected answer 2 let the consecutive whole numbers be x, x + 1. Such that 5 times the smaller plus	(i)learners are able to work independently with or without assistance (ii)those with difficulty with the guidance of the teacher they quickly recovered.

	thinking of ? Exercise 2 Find two consecutive whole numbers such that 5 times the smaller number plus three times the greater number makes 75.	3 times the greater thus, smaller 5x greater 3(x+1) i.e 5x + 3(x+1) =75 Simplify 5x+3x+3=75 collect like terms 8x =75-3 8x =72 Divide both sides by 8 $\frac{8x}{8} = \frac{72}{8}$ x = 9	
Conclusion	The teacher and students carryout the corrections. He collects the students note and mark them	The students see what they have by comparing their work with the teacher's correction made on the board	(i)the students judge their performance with the teacher and also know where their problem is if any
Home work and Assignment	The teacher gives assignment for students to solve at home as home work Exercise 1 I think of a number and I multiply it by 14 and I add 24 the result is 80.what is the number I am thinking of? Exercise 2	Students develop the habit of reading and revising what they had done in the school at home	(i)self study achieved (ii)develop interest for solving problems in Algebra (iii)develop ownership of knowledge

	The sum of four times a certain number and 29 is 89. Find the number. Exercise 3 When a number is added to another four times as big, the result is 30. Find the number. Exercise 4 The sum of three consecutive natural numbers is 72. Find the three numbers. Exercise 5 The sum of twice a certain number and 26 is 144. Find the number		

ACTIVITY-BASED LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON FOUR

Date: 1st February, 2021

Subject: Mathematics

Class: SS II

Average Age; 13 years

Duration: 40 mins

Gender: Male and Female

Topic: Algebraic Fraction

Sub-topic: Simple Algebraic Fraction

Instructional materials: New school Mathematics 2 for Junior Secondary Schools, National Mathematics Centre Teaching Module 2 for Junior Secondary Schools, Biro, Pencil, Killer, worksheets

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

(i) Simplify simple algebraic fractions
(ii) Simplify and manipulate equation with fraction correctly.
(iii) Apply the LCM method in solving algebraic fraction equations correctly

Previous Knowledge: The students have been taught simplification of simple equations

LESSON DEVELOPMENT ON SIMPLE ALGEBRAIC FRACTION

STAGE	TEACHER'S ACTIVITY	LEARNER'S ACTIVITY	LEARNING POINT
Introduction	The teacher groups the students and gives them problems on previous knowledge to solve. The teacher goes round to see what learners are doing. Later he asks them to present their findings	Learners solve the activities as required by the teachers Expected answer 1 Solve $5x-4=2x+11$ Subtract 2x from both sides	(i)flash back to the previous knowledge and recall (ii)utilization of the previous lesson and it connection to the

	Exercise 1 Solve the equation $5x-4=2x+11$ Exercise 2 Solve $5(x+11)+2(2x-5)=0$	we have $5x-2x-4=2x-2x+11$ 3x – 4 = 11 Add 4 to both sides 3x -4+4 = 11 +4 3x = 15 Divide both sides by 3 $\frac{3x}{3}=\frac{15}{3}$ x = 5 Expected answer 2 Solution 2 Solve $5(x+11)+2(2x-5)=0$ $5(x+11)+2(2x-5)=0$ Open the brackets 5x +55 +4x -10 =0 Collect like terms 9x + 45 = 0 Subtract 45 from both sides 9x +45 -45 = 0-45 9x = -45 Divide both sides by 9 $\frac{9x}{9}=\frac{-45}{9}$ x = -5	current lesson (iii)using the correct coefficient to have the correct value required (iv)ability to perform necessary skill required achieved

Presentation Step I	Teacher shares the learning materials to each group Teacher presents the lesson on algebraic fraction to students using appropriate examples and he involve the students at stages to make their contribution before wrap-up of the students ideas Example 1 Solve the equation $\frac{3x+2}{6}+\frac{2x+7}{9}=0$ The teacher asks them to find the LCM of this equation above. Thus the LCM of 6 and 9 is 18. Now multiply each term of the equation by 18 and get: $\frac{18(3x+2)}{6}+\frac{18(2x+7)}{9}=0\times18$ $3(3x+2)+2(2x+7)=0$ Open the brackets 9x+6+4x+14 =0 Collect like terms 13x +20 =0 Subtract 20 from both sides 13x+20-20 = 0-20 13x = -20 Divide both sides by 13	Learners and the teachers work together at all stages	(i)pay attention (ii)active participant (iii)developed minds-on and manipulation skills (iv)learners groups the lesson through the examples gives

	$\frac{13x}{13} = \frac{-20}{13}$ X= $\frac{-20}{13}$ Exercise 2 Solve the equation $\frac{3x-2}{4} - \frac{2x+7}{3} = 0$ Find the LCM OF 3and 4 which is 12. Now multiply each term of the equation by 12 $\frac{12(3x-2)}{4} - \frac{12(2x+7)}{3} = 0 \times 12$ 3(3x-2)-4(2x+7)=0 Open the brackets 9x – 6-8x-28=0 Collect the like terms x- 34 = 0 add 34 to both sides x – 34 +34 = 0 +34 x = 34		
Step II	Teacher gives the students the following activities to solve in their various group Exercise 1 Solve $\frac{x}{2} + \frac{3x}{4} = 5$ Exercise 2	Expected answers Solution 1 Solve $\frac{x}{2} + \frac{3x}{4} = 5$ LCM of 2 and 4 is 4	(i)learners consolidated the new concept (ii)ownership of the basic principles of solving Algebraic

	Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ Exercise 3 Solve $\frac{2y+7}{6}+\frac{y-5}{3}=0$ Exercise 4 $\frac{6m-3}{7}=\frac{2m+1}{7}$	Now multiply through by 4 $\frac{4(x)}{2}+\frac{4(3x)}{4}=5\times4$ 2x +3x =20 Collect like terms 5x = 20 Divide both sides by 5 $\frac{5x}{5}=\frac{20}{5}$ Solution 2 Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ LCM of 2 and 3 is 6 Multiply through by 6 $\frac{6(x-5)}{2}-\frac{6(x-4)}{3}=0\times6$ 3(x-5)-2(x-4) = 0 Open the brackets 3x-15-2x+8 =0 Collects like terms 5x-7=0 Add 7 to both sides 5x-7+7=0+7 5x=7 Divide both sides by 5 $\frac{5x}{5}=\frac{7}{5}$	fractions (iii)cooperative learning developed and enhanced

		$x = \frac{7}{5}$, $x = 1\frac{2}{5}$ Solution 3 $\frac{2y+7}{6} + \frac{y-5}{3} = 0$ LCM of 6 and 3is 6 Now multiply through by 6 $\frac{6(2y+7)}{6} + \frac{6(y-5)}{3} = 0 \times 6$ (2y+7)+2y-10=0 Collect like terms 4y-3 =0 Add 3 to both sides 4y-3+3 =0+3 4y=3 Divide both sides by 4 $\frac{4y}{4} = \frac{3}{4}$, $\therefore y = \frac{3}{4}$ Solution 4 $\frac{6m-3}{7} = \frac{2m+1}{7}$ LCM of 7 and 7 is 7 Now multiply through by 7 $\frac{7(6m-3)}{7} = \frac{7(2m+1)}{7}$ We have	

		6m-3 = 2m +1 Collect like terms 6m -2m = 1+3 4m =4 Divide through by 4 $\frac{4m}{4} = \frac{4}{4}$, m =1	
Step III	Teacher calls for group presentation of their findings presented by their representative. teacher will not allow one person to presents the group work for purpose of engaging everybody	Learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging areas. Teacher finally wrap-up the lesson to highlight difficult area of misconception	(i) Discovery of any faulty step taken in their group work (ii) Joint consciousness of the corrects facts and principles achieved
Evaluation	Teacher evaluates the lesson by given the following tasks for learners as class work to be solved individually. Teachers moves round to see what each students is doing and guide them where necessary Exercise 1 Solve $\frac{3m}{5} - \frac{m}{3} = \frac{8}{5}$	Expected answer 1 Solution 1 Solve $\frac{3m}{5} - \frac{m}{3} = \frac{8}{5}$ LCM = 15 Multiply through by 15 $\frac{15(3m)}{5} - \frac{15(m)}{3} = \frac{15(8)}{5}$ Reduce to the lowest level 3(3m)-5(m)=3(8) Open the brackets	(i)learners work independently with or without teacher's assistance (ii)teacher are able to discover those who needs more attention and are attended to quickly (iii)self learning developed

	Exercise 2 Solve $\frac{3(2a+1)}{4} = \frac{5(a+5)}{6}$ Exercise 3 Solve $\frac{3x}{7} = \frac{2x}{3} - \frac{1}{3}$	9m-5m=24 Collect like terms 4m = 24 Divide both sides by 4 $\frac{4m}{4} = \frac{24}{4}$ m = 6 Exercise 2 Solution 2 Solve $\frac{3(2a+1)}{4} = \frac{5(a+5)}{6}$ LCM of 4 and 6 is 24 Multiply through by 24 3×6(2a+1)=4×5(a+5) 18(2a+1)=20(a+5) Open the brackets 36a+18 =20a+100 Collect like terms 36a-20a =100-18 16a =72 Divide both sides by 16 $a = \frac{9}{2}$, $a = 4\frac{1}{2}$ Exercise 3 Solution 3 Solve $\frac{3x}{7} = \frac{2x}{3} - \frac{1}{3}$	

		LCM of 7 and 3 is 21 Multiply through by 21 $\frac{21(3x)}{7} = \frac{21(2x)}{3} - \frac{21(1)}{3}$ 3(3x) =7(2x) -7 9x = 14x -7 -5x = -7 Divide both sides by -5 $\frac{-5x}{-5} = \frac{-7}{-5}$ $x = 1\frac{2}{5}$	
	Exercise 4 $\frac{4t+3}{5} = \frac{t+3}{2}$	Exercise 4 Solution 4 Solve $\frac{4t+3}{5} = \frac{t+3}{2}$ LCM of 5 and 2 is 10 Multiply through by 10 $\frac{10(4t+3)}{5} = \frac{10(t+3)}{2}$ 2(4t+3) = 5(t+3) 8t +6 = 5t +15 Collect like terms 8t -5t = 15 -6 3t = 9 Divide both sides by 3	

		$\frac{3t}{3} = \frac{9}{3}$ t = 3	
Conclusion	Teacher and students carry out the corrections. He collects the students note book and mark them	The students see what they got and discovered their mistakes	(i)the students judge their performance with the teacher and also know their problem is if any
Home work	The following assignments are given to students as home work. Exercise 1 Solve $\frac{3n+1}{8} = 2$ Exercise 2 Solve $\frac{5e-1}{4} - \frac{7e+4}{8} = 0$ Exercise 3 Solve $\frac{2(8x+7)}{3} = \frac{5x}{9}$ Exercise 4 Solve $1\frac{1}{2} - \frac{3x}{4} = \frac{8x}{8}$	(i)learners develop the habit of reading and revising their class work at home (ii)solving of the task given by the teacher	(i)self study developed (ii)interest for solving problems in algebra developed (iii)develop ownership of knowledge and confident in solving problems in algebra

APPENDIX I

Problem-Solving Lesson Plan for Experimental Group

LESSON ONE

Date:	11th January, 2021
Week:	Two
Subject:	Mathematics
Topic:	Algebra
Sub-topic:	Expansion of Algebraic Expression
Class:	JSS II
Average Age:	13 years
Duration:	40mins
Methodology:	Problem Solving Approach
Behavioural Objectives:	By the end of the lesson students should be able to:
	(iii) Expand algebraic fractions
	(iv) Simplify the like terms

Previous Knowledge: Students are familiar with simplification of common fractions

Instructional materials:	Pencil, Biro, Worksheet
Reference materials:	New General Mathematics for Junior Secondary Schools
Rational:	The knowledge of algebraic fraction is very important to other science and engineering students in their previous lower classes were already familiar on how to solve fraction without variables attached. It is therefore very important for students to see further application of fraction with given algebraic fractions

LESSON DEVELOPMENT ON EXPANSION OF ALGEBRAIC FRACTIONS

Stage	Teachers Activity	Learners Activity	Learning Point
Introduction (5 mins)	Teacher group the students and give them problem on previous knowledge. The teacher goes round the groups and sees what they are doing. Later ask each group to present their findings. Example (i) simplify the expression $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ (ii) solve $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$	Learners carrying out the activity as instructed by the teacher <u>Expected solution</u> example (i) $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ using BODMAS $\frac{1}{2}\times\frac{3}{7}=\frac{3}{14}$ add $\frac{2}{7}$ to the above $\frac{3}{14}+\frac{2}{7}=\frac{3+4}{14}$ $=\frac{7}{14}-\frac{1}{7}=\frac{7-2}{14}$ $=\frac{5}{14}$ Example (ii) $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$ $=\frac{5}{28}+\frac{1}{6}=\frac{30+28}{148}$ $=\frac{58}{148}=\frac{29}{74}$	Learners to recall on the rule of BODMAS and it application to problems on simple fractions
Presentation	Teacher shares the learning materials to each group. The	Learners carry out activity such as instructed by the	(v) Leadership achieved (vi) Identification

Step I:	presents the lesson by describing to students on how to expand algebraic expression such as: example 1 Expand the expression $5(3x-2)+3(2x+6)$ first multiply and open the bracket term by term and collect like term	teacher. Expected answers 1 $5(3x-2)+3(2x+6)$ $=15x-10+6x+18$ Collect like terms $15x+6x+18-10$ $=21x+8$	of learning materials (vii) Ability to follow instructions to solve problems (viii) Self learning
Step II	Teacher gives the students activities to perform in their various groups	Task1: Expected result Expand $(2a+b)^2$ Expected answer: $(2a+b)^2 =$ $(2a+b)(2a+b)$ after interpreting as above $(2a+b)^2$ $= (2a+b)(2a+b)$ Expand the brackets by multiplying and then collect the like terms and perform the necessary operation. $(2a+b)(2a+b) =$	Students follow the given instructions to solve the task. First they discuss on how to go by the problem and agree before they put down their resolution on the activities given. They achieve on how to work in groups and members are able to participate actively

		$4a+2ab+2ab+b^2$ $= 4a^2+4ab+b^2$	
Step III	The teacher asks each group leader to report their findings so as to compare the result they obtained. Teacher evaluates the lesson by asking questions from the students to solve the following on their own in their note book Exercise 1: Expand $(3x+7)^2$ Exercise 2: Expand $5(3x+2)+(4x-1)^2$	All students are solving the given problems on their own without assistance from their classmate <u>Expected answer</u> Ex.1 expand $(3x+7)^2$ is interpreted as below $(3x+7)^2 =$ $(3x+7)(3x+7)$ Now multiply as follow $(3x+7)(3x+7) =$ $9x^2+21x+21x+49$ Collect like terms $9x^2+42x+49$ <u>Expected answer 2</u> Expand $5(3x+2)+(4x-1)^2$ $15x+10+16x^2-8x+1$ Collect the like terms as:	Ability to compare their work and see the area of their challenge. Each student is able to work independently without assistance and those who had difficulty along the line are able to discover their mistakes and learn how to solve problems

		$16x^2 + 15x - 8x + 10 + 1$ $= 16x^2 + 7x + 11$	
Conclusion	The teacher re-explains to the students on solving the problems given to the students. He collects their note books and mark them	Learners compare their work with the teacher's corrections made on the board	Compare their work with the teacher and also they now know how many they got correctly
Home work	The teacher gives the following problems to students as home work. Task 1: expand $(2a-7)^2$ task 2: expand $(5b+3)^2$ task 3: expand $3(2a-6) \quad +5(6a+3)$	Learners form the habit to revise what they have done in the school at home	Habit of reading and self study achieved

PROBLEM-SOLVING LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON TWO

Date: 18th January, 2021

Week: Two

Subject: Mathematics

Topic: Algebra

Sub-topic: Expansion of Algebraic Expression

Class: JSS II

Average Age: 13 years

Duration: 40mins

Methodology: Problem Solving Approach

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

(iv) Practically construct using cardboard sheet $p(a+b)=ap+bp$

(v) Practically construct using cardboard sheet $(a+b)^2=(a+b)(a+b)=a^2+2ab+b^2$

(vi) Practically construct with aid $(a-b)(a-b)=ac-ad-bc+bd$

Previous Knowledge: (i) Students are familiar with simplification of Algebraic Equations like $a(a+b)=a^2+ab$ without illustration in a diagram.

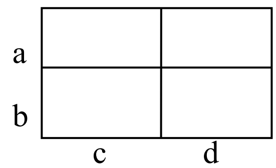
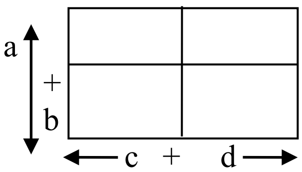
(ii) Find areas of rectangle, square using practical method

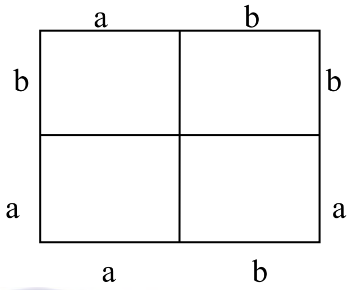
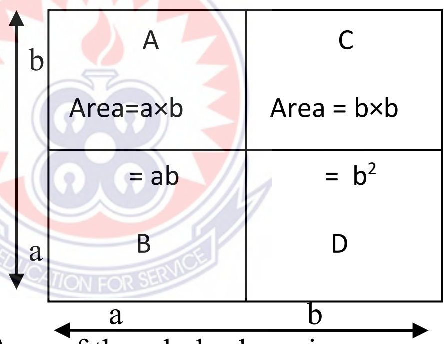
Instructional materials: cardboard sheets, pair of scissors, pencils, biro

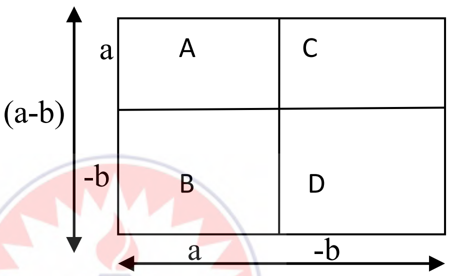
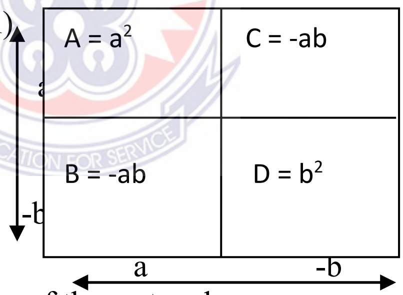
Reference materials: National Mathematical Centre Teaching Module for JS 2

Rational: The knowledge of algebraic expansion is essential to engineering and other sciences. Also the expression of some algebraic into diagrams to obtain solution aid the students motivation and academic performance

LESSON DEVELOPMENT ON ALGEBRAIC DIAGRAMATICALY

Stage	**Teachers Activity**	**Learners Activity**	**Learning Point**
Introduction	Teacher group the students and give them problems on previous knowledge. The teacher gives the students task to solve base on the their previous knowledge Example 1 Expand the expression $5(3x-2)+4(2x-1)$	Expected answers to example 1 $5(3x-2)+4(2x-1)$ The learners carry out the activity as instructed by the teacher. Expand $5(3x-2)+4(2x-1)$ $= 15x-10+8x-4$ $=23x-14$	Learners to recall on the previous knowledge problem solved. Work in group as directed by the teacher
Presentation Step I	The teacher shares the learning materials to each group and presents the first task to the students. Example 1: expand expression of the form $(a+b)(c+d)$ With the aid of diagram Guide the students to construct a rectangle of length $(a+b)$ And width (c + d)	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a,b,c,d (ii) label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii) find the area of the shape <u>Expected answer</u> (i)  (ii)  (iii) Area of the rectangle as given by the shape $(a+b)^2 = (a+b)\times(c+d)$	(i) Learners develop the ability to follow instructions. (ii) Develops learners' higher order thinking skill. (iii) Develop learners to see the relationship between the formula Area =length ×breadth As related to this rectangular shape. (iv) Working in groups become more meaningful to the learners

		$(a+b)^2=(a+b)(c+d)$ $=a(c+d)+b(c+d)$ $=ac+ad+bc+bd$	because they enjoyed working together
Step II	The teacher gives the following problems to the groups to try them in their groups using the diagram to illustrate them and solve Task 1 (i)expand the expression of the form $(a+b)^2$ (ii)using diagram to find the area occupied by the above expression	Students appoint their leaders of each of the group to coordinate them. Students carry out the task given. First re-express $(a+b)^2=(a+b)(a+b)$ on the diagram as below . leaners' partition a rectangle into four parts   Area of the whole shape is area =(a + b)× (a + b) $= a^2 + ab + ab + b^2$ $= a^2 + 2ab + b^2$ OR Sum up Area = (A + B + C + D) becomes Area(A +B +C +D) = $ab + a^2 + ab + b^2$ collect the like terms we have Area = $a^2 + 2ab + b^2$ Thus $(a+b)^2 = a^2 + 2ab + b^2$	(i) Leadership training achieved by the learners (ii) Recalling and follow the right step achieved (iii) Ownership of the knowledge for successful proving (iv) Ability to follow instruction to solve problems (v) Self learning confident developed

Step III	The teacher gives the students activities to perform in their groups Task 1 (i)expand the expression $(a-b)^2$ using diagram (ii)draw rectangle and divide it into four equal parts (iii)label the diagram a,-b,a,-b on each ssquarevshape (iv)find the area of the shape and otherwise the alternative method. The teacher moves round to guide the students while carry on the activities in each group	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a, b, c,d (ii)label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii)find the area of the shape Expected answer The learners draw the rectangle and partition it into four parts as below and label them as side a, -b, a, -b.  (iii)  Area of the rectangle Area = A + B+ C +D $= a^2 + (-ab) + (-ab) + b^2$ $= a^2 - 2ab + b^2$ Alternative method Area $=(a-b)^2 = (a-b)(a-b)$ Multiply the two brackets and gets $(a-b)(a-b) = a^2 -ab -ab + b^2$ $= a^2 - 2ab + b^2$	(i) Students follow the instructions they discussed and resolved. (ii) All members participate in the activity. (iii) They present their findings and compare their work with other groups

Step iv	The teacher asks each group to present Their findings	They all participate in solving the problems following the given instructions.	(i) Ability to work in groups (ii) Every student participates full in the given tasks. (iii) The leader of each group presents their findings. (iv) Learners are able to compare their findings with other groups. (v) They are able to overcome their challenges if any difference exists.
Conclusion	The teacher now wrap up the lesson by given emphasis to where they have differences in order to overcome their challenges	The students are able to notice if any difference exist and how to overcome it.	

PROBLEM-SOLVING LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON THREE

Date:	25th January, 2021
Subject:	Mathematics
Class:	SS II
Average Age;	13 years
Duration:	40 mins
Gender:	Male and Female
Topic:	Algebraic Equations
Sub-topic:	Word Problems
Instructional materials:	Biro, Pen, Pencil, Ruler, Worksheet, New General Mathematics for JSS Two
Behavioural Objectives:	By the end of the lesson the students should be able to:

(iii) Translate word problems leading to linear equations.
(iv) Solve the equations correctly.

Previous Knowledge: The students have been taught on how to solve linear equations

LESSON DEVELOPMENT ON WORD PROBLEMS

Stage	Teacher's Activity	Learner's Activity	Learning Points
Introduction	Teacher group the students and give them problems on previous knowledge to solve. The teacher goes round to see what each student is doing. Later he asks some of them from all the groups to present their findings. Exercise 1: Solve the equation $6x+5=23$ Exercise 2 Find the value of y in the equation $9-3y=27$	Learners carry out the activity as required <u>Expected Answers</u> solution 1 $6x+5=23$ Subtract 5 from both sides we get $6x+5-5=23-5$ $6x=18$ Divide both sides by 6 we get $\frac{6x}{6}=\frac{18}{6}$ $x=3$ Solution 2 $9-3y=27$ Subtract 9 from both sides we get $9-9-3y=27-9$ $-3y=18$ Divide both side by sides minus 3 (-3) $\frac{-3y}{-3}=\frac{18}{-3}$ $y=-6$	(i)Recall of previous lesson (ii)utilization of the previous lesson and connection (iii)Achieved the ability to manipulate the unwanted variables to a particular side he wants it to be without losing the value. (iv)how to collect the like terms (v)using the correct coefficient to have the value of the variable achieved.
Presentation Step I	The teacher shares the learning materials and work	Expected solution 1 Let the brothers age be (x+4), x the senior	Learners tryout the problem by collaboration to

	sheet to the learners in each group. The teacher presents the lesson on word problems on linear equations to students as examples and he involve the learners at every stage by first give room to students to participate at each level before he demonstrate or solve the problem. Each group should not more than five students Example 1 The sum of ages of two brothers is 18 years. If one is 4 years older than the other, find the ages of the two brothers. Learners use the worksheet and the teacher moves round the groups to see how the task and guide any group(s) who finds the problem difficult to solve by putting them on the way for them to continue	be (x+4) the junior be x. Thus $x+(x+4)=18$ Open the bracket $x+x+4=18$ Collect like terms $2x+4=18$ Subtract 4 from both side we have: $2x+4-4=18-4$ $2x=14$ Divide both sides by 2 $\frac{2x}{2}=\frac{14}{2}$ $x=7\,years$, if $x=7\,junior$ Then x+4 for senior 7+4 = 11 years $\therefore senior=11years$ $junior=7years$	arrive at the correct answer slow learners able to understand how to solve the problem through the explanation given by one of them who got it correctly. They become ownership of the lesson when the teacher approved their answers
Step II	Teacher gives the students the following activities	Expected answer 1 Let x represent the	(i)learners become consolidated of the new concepts (word

	to in their various groups Exercise 1 Suppose the sum of the ages of two students is 22years.if one of the students is 2 years older than the other, find the ages of the two students. Exercise 2 The difference between five times a number and twelve is 48.find the number	age of the first student x+2 represent the age of the second student total age = 22years thus, the sum of their ages are $x+(x+2)=22$ Open the bracket $x+x+2=22$ Collect like terms 2x+2 = 22 Subtract 2 from both sides 2x+2-2 =22-2 2x = 20 Divide both sides by 2 $\frac{2x}{2}=\frac{20}{2}$ x = 10 years and x+ 2 becomes 10 + 2 = 12 years $\therefore$ their ages are x = 10, x = 12 expected answer 2 let x be the number 5 times a number is 5x Now 5x -12 = 48	problem) in linear equation (ii)ownership of the basic principles of solving word problems in linear equations

		Add plus 12 (+12) to both sides we have: 5x-12+12 = 48 +12 5x = 60 Divide both sides by 5 $\frac{5x}{5} = \frac{60}{5}$ x = 12	
Step III	The teacher asks each group leader to present their findings	The learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging area	(i)discovery of faulty steps taken for the group who had difficulty (ii)conscientious agreement achieved
Evaluation	Teacher evaluates the lesson by given the following problems for the learners as class work to be solved individually. teacher moves round to see what each of them is doing Exercise 1 I think of number. I take away 14 and the result is 26. What number am I	Expected answer 1 Let the number be x If x is the number -14 i.e x -14 = 26 add 14 to both sides x -14+ 14 = 26 +14 x = 40 Expected answer 2 let the consecutive whole numbers be x, x + 1. Such that 5 times the smaller plus	(i)learners are able to work independently with or without assistance (ii)those with difficulty with the guidance of the teacher they quickly recovered.

	thinking of ? Exercise 2 Find two consecutive whole numbers such that 5 times the smaller number plus three times the greater number makes 75.	3 times the greater thus, smaller 5x greater 3(x+1) i.e 5x + 3(x+1) =75 Simplify 5x+3x+3=75 collect like terms 8x =75-3 8x =72 Divide both sides by 8 $\frac{8x}{8} = \frac{72}{8}$ x = 9	
Conclusion	The teacher and students carryout the corrections. He collects the students note and mark them	The students see what they have by comparing their work with the teacher's correction made on the board	(i)the students judge their performance with the teacher and also know where their problem is if any
Home work and Assignment	The teacher gives assignment for students to solve at home as home work Exercise 1 I think of a number and I multiply it by 14 and I add 24 the result is 80.what is the number I am thinking of? Exercise 2	Students develop the habit of reading and revising what they had done in the school at home	(i)self study achieved (ii)develop interest for solving problems in Algebra (iii)develop ownership of knowledge

	The sum of four times a certain number and 29 is 89. Find the number. Exercise 3 When a number is added to another four times as big, the result is 30. Find the number. Exercise 4 The sum of three consecutive natural numbers is 72. Find the three numbers. Exercise 5 The sum of twice a certain number and 26 is 144. Find the number		

PROBLEM-SOLVING LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON FOUR

Date: 1st February, 2021

Subject: Mathematics

Class: SS II

Average Age; 13 years

Duration: 40 mins

Gender: Male and Female

Topic: Algebraic Fraction

Sub-topic: Simple Algebraic Fraction

Instructional materials: New school Mathematics 2 for Junior Secondary Schools, National Mathematics Centre Teaching Module 2 for Junior Secondary Schools, Biro, Pencil, Killer, worksheets

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

(iv) Simplify simple algebraic fractions
(v) Simplify and manipulate equation with fraction correctly.
(vi) Apply the LCM method in solving algebraic fraction equations correctly

Previous Knowledge: The students have been taught simplification of simple equations

LESSON DEVELOPMENT ON SIMPLE ALGEBRAIC FRACTION

STAGE	TEACHER'S ACTIVITY	LEARNER'S ACTIVITY	LEARNING POINT
Introduction	The teacher groups the students and gives them problems on previous knowledge to solve. The teacher goes round to see what learners are doing. Later he asks them to present their findings	Learners solve the activities as required by the teachers Expected answer 1 Solve $5x-4=2x+11$ Subtract 2x from both sides	(i)flash back to the previous knowledge and recall (ii)utilization of the previous lesson and it connection to the

	Exercise 1 Solve the equation $5x-4=2x+11$ Exercise 2 Solve $5(x+11)+2(2x-5)=0$	we have $5x-2x-4=2x-2x+11$ 3x – 4 = 11 Add 4 to both sides 3x -4+4 = 11 +4 3x = 15 Divide both sides by 3 $\frac{3x}{3}=\frac{15}{3}$ x = 5 Expected answer 2 Solution 2 Solve $5(x+11)+2(2x-5)=0$ $5(x+11)+2(2x-5)=0$ Open the brackets 5x +55 +4x -10 =0 Collect like terms 9x + 45 = 0 Subtract 45 from both sides 9x +45 -45 = 0-45 9x = -45 Divide both sides by 9 $\frac{9x}{9}=\frac{-45}{9}$ x = -5	current lesson (iii)using the correct coefficient to have the correct value required (iv)ability to perform necessary skill required achieved

Presentation Step I	Teacher shares the learning materials to each group Teacher presents the lesson on algebraic fraction to students using appropriate examples and he involve the students at stages to make their contribution before wrap-up of the students ideas Example 1 Solve the equation $\frac{3x+2}{6}+\frac{2x+7}{9}=0$ The teacher asks them to find the LCM of this equation above. Thus the LCM of 6 and 9 is 18. Now multiply each term of the equation by 18 and get: $\frac{18(3x+2)}{6}+\frac{18(2x+7)}{9}=0\times18$ $3(3x+2)+2(2x+7)=0$ Open the brackets 9x+6+4x+14 =0 Collect like terms 13x +20 =0 Subtract 20 from both sides 13x+20-20 = 0-20 13x = -20 Divide both sides by 13	Learners and the teachers work together at all stages	(i)pay attention (ii)active participant (iii)developed minds-on and manipulation skills (iv)learners groups the lesson through the examples gives

<table>
<tr><td></td><td>$\frac{13x}{13} = \frac{-20}{13}$

X= $\frac{-20}{13}$

Exercise 2

Solve the equation

$\frac{3x-2}{4} - \frac{2x+7}{3} = 0$

Find the LCM OF 3and 4 which is 12.

Now multiply each term of the equation by 12

$\frac{12(3x-2)}{4} - \frac{12(2x+7)}{3} = 0 \times 12$

3(3x-2)-4(2x+7)=0

Open the brackets

9x – 6-8x-28=0

Collect the like terms

x- 34 = 0

add 34 to both sides

x – 34 +34 = 0 +34

x = 34</td><td></td><td></td></tr>
<tr><td>Step II</td><td>Teacher gives the students the following activities to solve in their various group

Exercise 1

Solve $\frac{x}{2} + \frac{3x}{4} = 5$

Exercise 2</td><td>Expected answers

Solution 1

Solve $\frac{x}{2} + \frac{3x}{4} = 5$

LCM of 2 and 4 is 4</td><td>(i)learners consolidated the new concept

(ii)ownership of the basic principles of solving Algebraic</td></tr>
</table>

	Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ Exercise 3 Solve $\frac{2y+7}{6}+\frac{y-5}{3}=0$ Exercise 4 $\frac{6m-3}{7}=\frac{2m+1}{7}$	Now multiply through by 4 $\frac{4(x)}{2}+\frac{4(3x)}{4}=5\times4$ 2x +3x =20 Collect like terms 5x = 20 Divide both sides by 5 $\frac{5x}{5}=\frac{20}{5}$ Solution 2 Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ LCM of 2 and 3 is 6 Multiply through by 6 $\frac{6(x-5)}{2}-\frac{6(x-4)}{3}=0\times6$ 3(x-5)-2(x-4) = 0 Open the brackets 3x-15-2x+8 =0 Collects like terms 5x-7=0 Add 7 to both sides 5x-7+7=0+7 5x=7 Divide both sides by 5 $\frac{5x}{5}=\frac{7}{5}$	fractions (iii)cooperative learning developed and enhanced

		$x = \frac{7}{5}$, $x = 1\frac{2}{5}$ Solution 3 $\frac{2y+7}{6} + \frac{y-5}{3} = 0$ LCM of 6 and 3is 6 Now multiply through by 6 $\frac{6(2y+7)}{6} + \frac{6(y-5)}{3} = 0 \times 6$ (2y+7)+2y-10=0 Collect like terms 4y-3 =0 Add 3 to both sides 4y-3+3 =0+3 4y=3 Divide both sides by 4 $\frac{4y}{4} = \frac{3}{4}$, $\therefore y = \frac{3}{4}$ Solution 4 $\frac{6m-3}{7} = \frac{2m+1}{7}$ LCM of 7 and 7 is 7 Now multiply through by 7 $\frac{7(6m-3)}{7} = \frac{7(2m+1)}{7}$ We have	

		6m-3 = 2m +1 Collect like terms 6m -2m = 1+3 4m =4 Divide through by 4 $\frac{4m}{4} = \frac{4}{4}$, m =1	
Step III	Teacher calls for group presentation of their findings presented by their representative. teacher will not allow one person to presents the group work for purpose of engaging everybody	Learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging areas. Teacher finally wrap-up the lesson to highlight difficult area of misconception	(i) Discovery of any faulty step taken in their group work (ii) Joint consciousness of the corrects facts and principles achieved
Evaluation	Teacher evaluates the lesson by given the following tasks for learners as class work to be solved individually. Teachers moves round to see what each students is doing and guide them where necessary Exercise 1 Solve $\frac{3m}{5} - \frac{m}{3} = \frac{8}{5}$	Expected answer 1 Solution 1 Solve $\frac{3m}{5} - \frac{m}{3} = \frac{8}{5}$ LCM = 15 Multiply through by 15 $\frac{15(3m)}{5} - \frac{15(m)}{3} = \frac{15(8)}{5}$ Reduce to the lowest level 3(3m)-5(m)=3(8) Open the brackets	(i)learners work independently with or without teacher's assistance (ii)teacher are able to discover those who needs more attention and are attended to quickly (iii)self learning developed

	Exercise 2 Solve $\frac{3(2a+1)}{4}=\frac{5(a+5)}{6}$ Exercise 3 Solve $\frac{3x}{7}=\frac{2x}{3}-\frac{1}{3}$	9m-5m=24 Collect like terms 4m = 24 Divide both sides by 4 $\frac{4m}{4}=\frac{24}{4}$ m = 6 Exercise 2 Solution 2 Solve $\frac{3(2a+1)}{4}=\frac{5(a+5)}{6}$ LCM of 4 and 6 is 24 Multiply through by 24 3×6(2a+1)=4×5(a+5) 18(2a+1)=20(a+5) Open the brackets 36a+18 =20a+100 Collect like terms 36a-20a =100-18 16a =72 Divide both sides by 16 $a=\frac{9}{2}$, $a=4\frac{1}{2}$ Exercise 3 Solution 3 Solve $\frac{3x}{7}=\frac{2x}{3}-\frac{1}{3}$	

	Exercise 4 $\frac{4t+3}{5} = \frac{t+3}{2}$	LCM of 7 and 3 is 21 Multiply through by 21 $\frac{21(3x)}{7} = \frac{21(2x)}{3} - \frac{21(1)}{3}$ 3(3x) =7(2x) -7 9x = 14x -7 -5x = -7 Divide both sides by -5 $\frac{-5x}{-5} = \frac{-7}{-5}$ $x = 1\frac{2}{5}$ Exercise 4 Solution 4 Solve $\frac{4t+3}{5} = \frac{t+3}{2}$ LCM of 5 and 2 is 10 Multiply through by 10 $\frac{10(4t+3)}{5} = \frac{10(t+3)}{2}$ 2(4t+3) = 5(t+3) 8t +6 = 5t +15 Collect like terms 8t -5t = 15 -6 3t = 9 Divide both sides by 3	

		$\frac{3t}{3} = \frac{9}{3}$ t = 3	
Conclusion	Teacher and students carry out the corrections. He collects the students note book and mark them	The students see what they got and discovered their mistakes	(i)the students judge their performance with the teacher and also know their problem is if any
Home work	The following assignments are given to students as home work. Exercise 1 Solve $\frac{3n+1}{8} = 2$ Exercise 2 Solve $\frac{5e-1}{4} - \frac{7e+4}{8} = 0$ Exercise 3 Solve $\frac{2(8x+7)}{3} = \frac{5x}{9}$ Exercise 4 Solve $1\frac{1}{2} - \frac{3x}{4} = \frac{8x}{8}$	(i)learners develop the habit of reading and revising their class work at home (ii)solving of the task given by the teacher	(i)self study developed (ii)interest for solving problems in algebra developed (iii)develop ownership of knowledge and confident in solving problems in algebra

APPENDIX J

Guided-Discovery Lesson Plan for Experimental Group

LESSON ONE

Date:	11th January, 2021
Week:	Two
Subject:	Mathematics
Topic:	Algebra
Sub-topic:	Expansion of Algebraic Expression
Class:	JSS II
Average Age:	13 years
Duration:	40mins
Methodology:	Guided Discovery Approach
Behavioural Objectives:	By the end of the lesson students should be able to:
	(v) Expand algebraic fractions
	(vi) Simplify the like terms

Previous Knowledge: Students are familiar with simplification of common fractions

Instructional materials:	Pencil, Biro, Worksheet
Reference materials:	New General Mathematics for Junior Secondary Schools
Rational:	The knowledge of algebraic fraction is very important to other science and engineering students in their previous lower classes were already familiar on how to solve fraction without variables attached. It is therefore very important for students to see further application of fraction with given algebraic fractions

LESSON DEVELOPMENT ON EXPANSION OF ALGEBRAIC FRACTIONS

Stage	Teacher's Activity	Learner's Activity	Learning Point
Introductio n (5 mins)	Teacher group the students and give them problem on previous knowledge. The teacher goes round the groups and sees what they are doing. Later ask each group to present their findings. Example (i) simplify the expression $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ (ii) solve $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$	Learners carrying out the activity as instructed by the teacher <u>Expected solution</u> example (i) $\frac{1}{2}\times\frac{3}{7}-\frac{1}{7}\times\frac{2}{7}$ using BODMAS $\frac{1}{2}\times\frac{3}{7}=\frac{3}{14}$ add $\frac{2}{7}$ to the above $\frac{3}{14}+\frac{2}{7}=\frac{3+4}{14}$ $=\frac{7}{14}-\frac{1}{7}=\frac{7-2}{14}$ $=\frac{5}{14}$ Example (ii) $\left(\frac{1}{4}\times\frac{5}{7}\right)+\left(\frac{1}{2}\times\frac{1}{3}\right)$ $=\frac{5}{28}+\frac{1}{6}=\frac{30+28}{148}$ $=\frac{58}{148}=\frac{29}{74}$	Learners to recall on the rule of BODMAS and it application to problems on simple fractions

Presentation Step I:	Teacher shares the learning materials to each group. The presents the lesson by describing to students on how to expand algebraic expression such as: example 1 Expand the expression $5(3x-2)+3(2x+6)$ first multiply and open the bracket term by term and collect like term	Learners carry out activity such as instructed by the teacher. Expected answers 1 $5(3x-2)+3(2x+6)$ $=15x-10+6x+18$ Collect like terms $15x+6x+18-10$ $=21x+8$	(ix) Leadership achieved (x) Identification of learning materials (xi) Ability to follow instructions to solve problems (xii) Self learning
Step II	Teacher gives the students activities to perform in their various groups	Task1: Expected result Expand $(2a+b)^2$ Expected answer: $(2a+b)^2 =$ $(2a+b)(2a+b)$ after interpreting as above $(2a+b)^2$ $= (2a+b)(2a+b)$ Expand the brackets by multiplying and then collect the like terms and perform the	Students follow the given instructions to solve the task. First they discuss on how to go by the problem and agree before they put down their resolution on the activities given. They achieve on how to work in groups and members are able to participate actively

		necessary operation. $(2a+b)(2a+b) =$ $4a+2ab+2ab+b^2$ $= 4a^2 + 4ab + b^2$	
Step III	The teacher asks each group leader to report their findings so as to compare the result they obtained. Teacher evaluates the lesson by asking questions from the students to solve the following on their own in their note book Exercise 1: Expand $(3x+7)^2$ Exercise 2: Expand $5(3x+2)+(4x-1)^2$	All students are solving the given problems on their own without assistance from their classmate <u>Expected answer</u> Ex.1 expand $(3x+7)^2$ is interpreted as below $(3x+7)^2 =$ $(3x+7)(3x+7)$ Now multiply as follow $(3x+7)(3x+7) =$ $9x^2 + 21x + 21x + 49$ Collect like terms $9x^2 + 42x + 49$ <u>Expected answer 2</u> Expand $5(3x+2)+(4x-1)^2$ $15x + 10 + 16x^2 - 8x + 1$ Collect the like terms	Ability to compare their work and see the area of their challenge. Each student is able to work independently without assistance and those who had difficulty along the line are able to discover their mistakes and learn how to solve problems

		as: $16x^2 + 15x - 8x + 10 + 1$ $= 16x^2 + 7x + 11$	
Conclusion	The teacher re-explains to the students on solving the problems given to the students. He collects their note books and mark them	Learners compare their work with the teacher's corrections made on the board	Compare their work with the teacher and also they now know how many they got correctly
Home work	The teacher gives the following problems to students as home work. Task 1: expand $(2a-7)^2$ task 2: expand $(5b+3)^2$ task 3: expand $3(2a-6) \quad +5(6a+3)$	Learners form the habit to revise what they have done in the school at home	Habit of reading and self study achieved

GUIDED-DISCOVERY LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON TWO

Date: 18th January, 2021

Week: Two

Subject: Mathematics

Topic: Algebra

Sub-topic: Expansion of Algebraic Expression

Class: JSS II

Average Age: 13 years

Duration: 40mins

Methodology: Guided Discovery Approach

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

(vii) Practically construct using cardboard sheet
$p(a+b) = ap + bp$

(viii) Practically construct using cardboard sheet
$(a+b)^2 = (a+b)(a+b) = a^2 + 2ab + b^2$

(ix) Practically construct with aid
$(a-b)(a-b) = ac - ad - bc + bd$

Previous Knowledge: (i) Students are familiar with simplification of Algebraic Equations like $a(a+b) = a^2 + ab$ without illustration in a diagram.

(ii) Find areas of rectangle, square using practical method

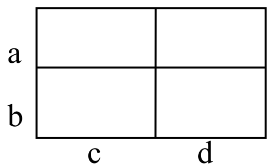
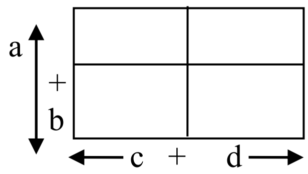
Instructional materials: cardboard sheets, pair of scissors, pencils, biro

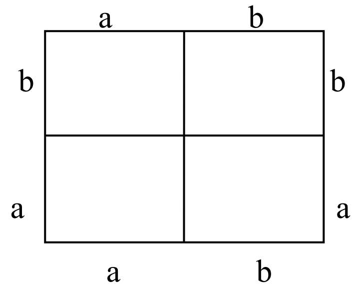
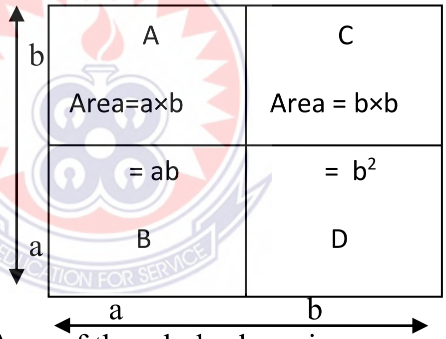
Reference materials: National Mathematical Centre Teaching Module for JS 2

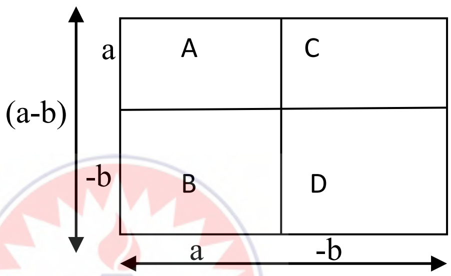
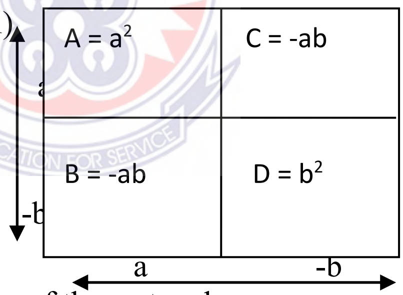
Rational: The knowledge of algebraic expansion is essential to engineering

and other sciences. Also the expression of some algebraic into diagrams to obtain solution aid the students motivation and academic performance

LESSON DEVELOPMENT ON ALGEBRAIC DIAGRAMATICALY

Stage	Teachers Activity	Learners Activity	Learning Point
Introduction	Teacher group the students and give them problems on previous knowledge. The teacher gives the students task to solve base on the their previous knowledge Example 1 Expand the expression $5(3x-2)+4(2x-1)$	Expected answers to example 1 $5(3x-2)+4(2x-1)$ The learners carry out the activity as instructed by the teacher. Expand $5(3x-2)+4(2x-1)$ $= 15x-10+8x-4$ $=23x-14$	Learners to recall on the previous knowledge problem solved. Work in group as directed by the teacher
Presentation Step I	The teacher shares the learning materials to each group and presents the first task to the students. Example 1: expand expression of the form $(a+b)(c+d)$ With the aid of diagram Guide the students to construct a rectangle of length $(a+b)$ And width (c + d)	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a,b,c,d (ii) label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii) find the area of the shape <u>Expected answer</u> (i)  (ii)  (iii) Area of the rectangle as given by the shape $(a+b)^2=(a+b)\times(c+d)$	(i) Learners develop the ability to follow instructions. (ii) Develops learners' higher order thinking skill. (iii) Develop learners to see the relationship between the formula Area =length ×breadth As related to this rectangular shape. (iv) Working in groups become more meaningful to the learners

		$(a+b)^2=(a+b)(c+d)$ $=a(c+d)+b(c+d)$ $=ac+ad+bc+bd$	because they enjoyed working together
Step II	The teacher gives the following problems to the groups to try them in their groups using the diagram to illustrate them and solve Task 1 (i)expand the expression of the form $(a+b)^2$ (ii)using diagram to find the area occupied by the above expression	Students appoint their leaders of each of the group to coordinate them. Students carry out the task given. First re-express $(a+b)^2=(a+b)(a+b)$ on the diagram as below . leaners' partition a rectangle into four parts   Area of the whole shape is area $=(a+b)\times(a+b)$ $= a^2 + ab + ab + b^2$ $= a^2 + 2ab + b^2$ OR Sum up Area = (A + B + C + D) becomes Area(A +B +C +D) = $ab + a^2 + ab + b^2$ collect the like terms we have Area = $a^2 + 2ab + b^2$ Thus $(a+b)^2 = a^2 + 2ab + b^2$	(i) Leadership training achieved by the learners (ii) Recalling and follow the right step achieved (iii) Ownership of the knowledge for successful proving (iv) Ability to follow instruction to solve problems (v) Self learning confident developed

Step III	The teacher gives the students activities to perform in their groups Task 1 (i)expand the expression $(a-b)^2$ using diagram (ii)draw rectangle and divide it into four equal parts (iii)label the diagram a,-b,a,-b on each ssquarevshape (iv)find the area of the shape and otherwise the alternative method. The teacher moves round to guide the students while carry on the activities in each group	Learners carryout the instructions as stated below (i)divide the rectangle into four equal parts and label each shape a, b, c,d (ii)label the rectangle of length $(a+b)$ and breadth $(c+d)$ (iii)find the area of the shape Expected answer The learners draw the rectangle and partition it into four parts as below and label them as side a, -b, a, -b.  (iii)  Area of the rectangle Area = A + B+ C +D $= a^2 + (-ab) + (-ab) + b^2$ $= a^2 - 2ab + b^2$ Alternative method Area $=(a-b)^2 = (a-b)(a-b)$ Multiply the two brackets and gets $(a-b)(a-b) = a^2 - ab - ab + b^2$ $= a^2 - 2ab + b^2$	(i) Students follow the instructions they discussed and resolved. (ii) All members participate in the activity. (iii) They present their findings and compare their work with other groups

Step iv	The teacher asks each group to present Their findings	They all participate in solving the problems following the given instructions.	(i) Ability to work in groups (ii) Every student participates full in the given tasks. (iii) The leader of each group presents their findings. (iv) Learners are able to compare their findings with other groups. (v) They are able to overcome their challenges if any difference exists.
Conclusion	The teacher now wrap up the lesson by given emphasis to where they have differences in order to overcome their challenges	The students are able to notice if any difference exist and how to overcome it.	

GUIDED-DISCOVERY LESSON PLAN FOR EXPERIMENTAL GROUP
LESSON THREE

Date: 25th January, 2021

Subject: Mathematics

Class: SS II

Average Age; 13 years

Duration: 40 mins

Gender: Male and Female

Topic: Algebraic Equations

Sub-topic: Word Problems

Instructional materials: Biro, Pen, Pencil, Ruler, Worksheet, New General Mathematics for JSS Two

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

(v) Translate word problems leading to linear equations.

(vi) Solve the equations correctly.

Previous Knowledge: The students have been taught on how to solve linear equations

LESSON DEVELOPMENT ON WORD PROBLEMS

Stage	Teacher's Activity	Learner's Activity	Learning Points
Introduction	Teacher group the students and give them problems on previous knowledge to solve. The teacher goes round to see what each student is doing. Later he asks some of them from all the groups to present their findings. Exercise 1: Solve the equation $6x+5=23$ Exercise 2 Find the value of y in the equation $9-3y=27$	Learners carry out the activity as required <u>Expected Answers</u> solution 1 $6x+5=23$ Subtract 5 from both sides we get $6x+5-5=23-5$ $6x=18$ Divide both sides by 6 we get $\frac{6x}{6}=\frac{18}{6}$ $x=3$ Solution 2 $9-3y=27$ Subtract 9 from both sides we get $9-9-3y=27-9$ $-3y=18$ Divide both side by sides minus 3 (-3) $\frac{-3y}{-3}=\frac{18}{-3}$ $y=-6$	(i)Recall of previous lesson (ii)utilization of the previous lesson and connection (iii)Achieved the ability to manipulate the unwanted variables to a particular side he wants it to be without losing the value. (iv)how to collect the like terms (v)using the correct coefficient to have the value of the variable achieved.

Presentation Step I	The teacher shares the learning materials and work sheet to the learners in each group. The teacher presents the lesson on word problems on linear equations to students as examples and he involve the learners at every stage by first give room to students to participate at each level before he demonstrate or solve the problem. Each group should not more than five students Example 1 The sum of ages of two brothers is 18 years. If one is 4 years older than the other, find the ages of the two brothers. Learners use the worksheet and the teacher moves round the groups to see how the task and guide any group(s) who finds the problem difficult to solve by putting them on the way for them to continue	Expected solution 1 Let the brothers age be (x+4), x the senior be (x+4) the junior be x. Thus $x+(x+4)=18$ Open the bracket $x+x+4=18$ Collect like terms $2x+4=18$ Subtract 4 from both side we have: $2x+4-4=18-4$ $2x=14$ Divide both sides by 2 $\frac{2x}{2}=\frac{14}{2}$ $x=7 years$, if $x=7 junior$ Then x+4 for senior 7+4 = 11 years $\therefore senior=11 years$ $junior=7 years$	Learners tryout the problem by collaboration to arrive at the correct answer slow learners able to understand how to solve the problem through the explanation given by one of them who got it correctly. They become ownership of the lesson when the teacher approved their answers

Step II	Teacher gives the students the following activities to in their various groups Exercise 1 Suppose the sum of the ages of two students is 22years.if one of the students is 2 years older than the other, find the ages of the two students. Exercise 2 The difference between five times a number and twelve is 48.find the number	Expected answer 1 Let x represent the age of the first student x+2 represent the age of the second student total age = 22years thus, the sum of their ages are $x+(x+2)=22$ Open the bracket $x+x+2=22$ Collect like terms 2x+2 = 22 Subtract 2 from both sides 2x+2-2 =22-2 2x = 20 Divide both sides by 2 $\frac{2x}{2}=\frac{20}{2}$ x = 10 years and x+ 2 becomes 10 + 2 = 12 years $\therefore$ their ages are x = 10, x = 12 expected answer 2 let x be the number 5 times a number is	(i)learners become consolidated of the new concepts (word problem) in linear equation (ii)ownership of the basic principles of solving word problems in linear equations

		5x Now 5x -12 = 48 Add plus 12 (+12) to both sides we have: 5x-12+12 = 48 +12 5x = 60 Divide both sides by 5 $\frac{5x}{5} = \frac{60}{5}$ x = 12	
Step III	The teacher asks each group leader to present their findings	The learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging area	(i)discovery of faulty steps taken for the group who had difficulty (ii)conscientious agreement achieved
Evaluation	Teacher evaluates the lesson by given the following problems for the learners as class work to be solved individually. teacher moves round to see what each of them is doing Exercise 1 I think of number. I	Expected answer 1 Let the number be x If x is the number -14 i.e x -14 = 26 add 14 to both sides x -14+ 14 = 26 +14 x = 40 Expected answer 2	(i)learners are able to work independently with or without assistance (ii)those with difficulty with the guidance of the teacher they quickly recovered.

	take away 14 and the result is 26. What number am I thinking of ? Exercise 2 Find two consecutive whole numbers such that 5 times the smaller number plus three times the greater number makes 75.	let the consecutive whole numbers be x, x + 1. Such that 5 times the smaller plus 3 times the greater thus, smaller 5x greater 3(x+1) i.e 5x + 3(x+1) =75 Simplify 5x+3x+3=75 collect like terms 8x =75-3 8x =72 Divide both sides by 8 $\frac{8x}{8} = \frac{72}{8}$ x = 9	
Conclusion	The teacher and students carryout the corrections. He collects the students note and mark them	The students see what they have by comparing their work with the teacher's correction made on the board	(i)the students judge their performance with the teacher and also know where their problem is if any
Home work and Assignment	The teacher gives assignment for students to solve at home as home work Exercise 1 I think of a number and I multiply it by 14 and I add 24 the result is 80.what is	Students develop the habit of reading and revising what they had done in the school at home	(i)self study achieved (ii)develop interest for solving problems in Algebra (iii)develop ownership of knowledge

	the number I am thinking of? Exercise 2 The sum of four times a certain number and 29 is 89. Find the number. Exercise 3 When a number is added to another four times as big, the result is 30. Find the number. Exercise 4 The sum of three consecutive natural numbers is 72. Find the three numbers. Exercise 5 The sum of twice a certain number and 26 is 144. Find the number		

GUIDED-DISCOVERY LESSON PLAN FOR EXPERIMENTAL GROUP

LESSON FOUR

Date: 1st February, 2021

Subject: Mathematics

Class: SS II

Average Age; 13 years

Duration: 40 mins

Gender: Male and Female

Topic: Algebraic Fraction

Sub-topic: Simple Algebraic Fraction

Instructional materials: New school Mathematics 2 for Junior Secondary Schools, National

Mathematics Centre Teaching Module 2 for Junior Secondary Schools, Biro, Pencil, Killer, worksheets

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

(vii) Simplify simple algebraic fractions
(viii) Simplify and manipulate equation with fraction correctly.
(ix) Apply the LCM method in solving algebraic fraction equations correctly

Previous Knowledge: The students have been taught simplification of simple equations

LESSON DEVELOPMENT ON SIMPLE ALGEBRAIC FRACTION

STAGE	TEACHER'S ACTIVITY	LEARNER'S ACTIVITY	LEARNING POINT
Introduction	The teacher groups the students and gives them problems on previous knowledge to solve. The teacher goes round to see what learners are doing. Later he asks them to present their findings Exercise 1 Solve the equation $5x-4=2x+11$ Exercise 2 Solve $5(x+11)+2(2x-5)=0$	Learners solve the activities as required by the teachers Expected answer 1 Solve $5x-4=2x+11$ Subtract 2x from both sides we have $5x-2x-4=2x-2x+11$ $3x - 4 = 11$ Add 4 to both sides $3x -4+4 = 11 +4$ $3x = 15$ Divide both sides by 3 $\frac{3x}{3}=\frac{15}{3}$ $x = 5$ Expected answer 2 Solution 2 Solve $5(x+11)+2(2x-5)=0$ $5(x+11)+2(2x-5)=0$ Open the brackets $5x +55 +4x -10 =0$ Collect like terms $9x + 45 = 0$	(i)flash back to the previous knowledge and recall (ii)utilization of the previous lesson and it connection to the current lesson (iii)using the correct coefficient to have the correct value required (iv)ability to perform necessary skill required achieved

		Subtract 45 from both sides 9x +45 -45 = 0-45 9x = -45 Divide both sides by 9 $\frac{9x}{9} = \frac{-45}{9}$ x = -5	
Presentation Step I	Teacher shares the learning materials to each group Teacher presents the lesson on algebraic fraction to students using appropriate examples and he involve the students at stages to make their contribution before wrap-up of the students ideas Example 1 Solve the equation $\frac{3x+2}{6} + \frac{2x+7}{9} = 0$ The teacher asks them to find the LCM of this equation above. Thus the LCM of 6 and 9 is 18. Now multiply each term of the equation by 18 and get: $\frac{18(3x+2)}{6} + \frac{18(2x+7)}{9} = 0 \times 18$ $3(3x+2) + 2(2x+7) = 0$ Open the brackets	Learners and the teachers work together at all stages	(i)pay attention (ii)active participant (iii)developed minds-on and manipulation skills (iv)learners groups the lesson through the examples gives

	9x+6+4x+14 =0 Collect like terms 13x +20 =0 Subtract 20 from both sides 13x+20-20 = 0-20 13x = -20 Divide both sides by 13 $\frac{13x}{13} = \frac{-20}{13}$ X= $\frac{-20}{13}$ Exercise 2 Solve the equation $\frac{3x-2}{4} - \frac{2x+7}{3} = 0$ Find the LCM OF 3and 4 which is 12. Now multiply each term of the equation by 12 $\frac{12(3x-2)}{4} - \frac{12(2x+7)}{3} = 0 \times 12$ 3(3x-2)-4(2x+7)=0 Open the brackets 9x – 6-8x-28=0 Collect the like terms x- 34 = 0 add 34 to both sides x – 34 +34 = 0 +34		

	x = 34		
Step II	Teacher gives the students the following activities to solve in their various group Exercise 1 Solve $\frac{x}{2}+\frac{3x}{4}=5$ Exercise 2 Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ Exercise 3 Solve $\frac{2y+7}{6}+\frac{y-5}{3}=0$ Exercise 4 $\frac{6m-3}{7}=\frac{2m+1}{7}$	Expected answers Solution 1 Solve $\frac{x}{2}+\frac{3x}{4}=5$ LCM of 2 and 4 is 4 Now multiply through by 4 $\frac{4(x)}{2}+\frac{4(3x)}{4}=5\times4$ 2x +3x =20 Collect like terms 5x = 20 Divide both sides by 5 $\frac{5x}{5}=\frac{20}{5}$ Solution 2 Solve $\frac{x-5}{2}-\frac{x-4}{3}=0$ LCM of 2 and 3 is 6 Multiply through by 6 $\frac{6(x-5)}{2}-\frac{6(x-4)}{3}=0\times6$ 3(x-5)-2(x-4) = 0 Open the brackets 3x-15-2x+8 =0 Collects like terms	(i)learners consolidated the new concept (ii)ownership of the basic principles of solving Algebraic fractions (iii)cooperative learning developed and enhanced

		5x-7=0 Add 7 to both sides 5x-7+7=0+7 5x=7 Divide both sides by 5 $\frac{5x}{5}=\frac{7}{5}$ $x=\frac{7}{5}$, $x=1\frac{2}{5}$ Solution 3 $\frac{2y+7}{6}+\frac{y-5}{3}=0$ LCM of 6 and 3is 6 Now multiply through by 6 $\frac{6(2y+7)}{6}+\frac{6(y-5)}{3}=0\times 6$ (2y+7)+2y-10=0 Collect like terms 4y-3 =0 Add 3 to both sides 4y-3+3 =0+3 4y=3 Divide both sides by 4 $\frac{4y}{4}=\frac{3}{4}$, $\therefore y=\frac{3}{4}$ Solution 4	

		$\frac{6m-3}{7}=\frac{2m+1}{7}$ LCM of 7 and 7 is 7 Now multiply through by 7 $\frac{7(6m-3)}{7}=\frac{7(2m+1)}{7}$ We have 6m-3 = 2m +1 Collect like terms 6m -2m = 1+3 4m =4 Divide through by 4 $\frac{4m}{4}=\frac{4}{4}$, m =1	
Step III	Teacher calls for group presentation of their findings presented by their representative. teacher will not allow one person to presents the group work for purpose of engaging everybody	Learners pay attention to the presentation of each group leader and critics are done by the learners guided by the teacher for any challenging areas. Teacher finally wrap-up the lesson to highlight difficult area of misconception	(i) Discovery of any faulty step taken in their group work (ii) Joint consciousness of the corrects facts and principles achieved
Evaluation	Teacher evaluates the lesson by given the following tasks for learners as class work to be solved individually. Teachers moves round to see what each students is doing and guide them where necessary	Expected answer 1 Solution 1 Solve $\frac{3m}{5}-\frac{m}{3}=\frac{8}{5}$ LCM = 15	(i)learners work independently with or without teacher's assistance (ii)teacher are

	Exercise 1 Solve $\frac{3m}{5}-\frac{m}{3}=\frac{8}{5}$ Exercise 2 Solve $\frac{3(2a+1)}{4}=\frac{5(a+5)}{6}$	Multiply through by 15 $\frac{15(3m)}{5}-\frac{15(m)}{3}=\frac{15(8)}{5}$ Reduce to the lowest level 3(3m)-5(m)=3(8) Open the brackets 9m-5m=24 Collect like terms 4m = 24 Divide both sides by 4 $\frac{4m}{4}=\frac{24}{4}$ m = 6 Exercise 2 Solution 2 Solve $\frac{3(2a+1)}{4}=\frac{5(a+5)}{6}$ LCM of 4 and 6 is 24 Multiply through by 24 3×6(2a+1)=4×5(a+5) 18(2a+1)=20(a+5) Open the brackets 36a+18 =20a+100 Collect like terms 36a-20a =100-18 16a =72	able to discover those who needs more attention and are attended to quickly (iii)self learning developed

	Exercise 3 Solve $\frac{3x}{7} = \frac{2x}{3} - \frac{1}{3}$ Exercise 4 $\frac{4t+3}{5} = \frac{t+3}{2}$	Divide both sides by 16 $a = \frac{9}{2}$, $a = 4\frac{1}{2}$ Exercise 3 Solution 3 Solve $\frac{3x}{7} = \frac{2x}{3} - \frac{1}{3}$ LCM of 7 and 3 is 21 Multiply through by 21 $\frac{21(3x)}{7} = \frac{21(2x)}{3} - \frac{21(1)}{3}$ 3(3x) =7(2x) -7 9x = 14x -7 -5x = -7 Divide both sides by -5 $\frac{-5x}{-5} = \frac{-7}{-5}$ $x = 1\frac{2}{5}$ Exercise 4 Solution 4 Solve $\frac{4t+3}{5} = \frac{t+3}{2}$ LCM of 5 and 2 is 10 Multiply through by 10 $\frac{10(4t+3)}{5} = \frac{10(t+3)}{2}$ 2(4t+3) = 5(t+3)	

		8t +6 = 5t +15 Collect like terms 8t -5t = 15 -6 3t = 9 Divide both sides by 3 $\frac{3t}{3} = \frac{9}{3}$ t = 3	
Conclusion	Teacher and students carry out the corrections. He collects the students note book and mark them	The students see what they got and discovered their mistakes	(i)the students judge their performance with the teacher and also know their problem is if any
Home work	The following assignments are given to students as home work. Exercise 1 Solve $\frac{3n+1}{8} = 2$ Exercise 2 Solve $\frac{5e-1}{4} - \frac{7e+4}{8} = 0$ Exercise 3 Solve $\frac{2(8x+7)}{3} = \frac{5x}{9}$ Exercise 4 Solve $1\frac{1}{2} - \frac{3x}{4} = \frac{8x}{8}$	(i)learners develop the habit of reading and revising their class work at home (ii)solving of the task given by the teacher	(i)self study developed (ii)interest for solving problems in algebra developed (iii)develop ownership of knowledge and confident in solving problems in algebra

APPENDIX K

Lesson Plan for Control Group

LESSON ONE

Date: 11th January, 2021

Subject: Mathematics

Class: JSS II

Average Age: 13 years

Duration: 40 minutes

Gender: Mixed

Topic: Algebra

Sub-Topic: Algebraic Fraction

Instructional Materials: New General Mathematics Book 2, work book/work sheet, pencil, biro, cleaners.

Behavioural Objectives: By the end of the lesson, the learners should be able to:

(i) Simplify simple algebraic fractions.
(ii) Simplify and manipulate equation with fraction correctly.
(iii) The L.C.M method in solving algebraic fraction equation correctly.

Previous Knowledge: The students have been taught simplification of simple equations.

Introduction: The teacher engaged the students based on the previous knowledge such as: (i) Solve the equation 5x – 4 = 2x + 11

(ii) Solve 5(x+11) + 2(2x – 5) = 0

Presentation: The teacher presents the lesson step by step to solve some examples for students to follow in doing the class work as follow:

Step 1: The teacher solved the problems below for the students to see.

Example 1: solve the equation $\frac{3x+2}{6}+\frac{2x+7}{9}=0$

Example 2: solve the equation $\frac{3x-2}{4}+\frac{2x+7}{3}=0$

The teacher demonstrates the process of solving these problems above with little or no students' participation of the above problems.

Step II: The teacher gives the following problems on board for students to solve by selecting those he wants to solve the task.

Exercise 1: solve $\frac{x}{2} + \frac{3x}{4} = 5$

Exercise 2: solve $\frac{x-5}{2} - \frac{x-4}{3} = 0$

Step III: The teacher gives the following algebraic equations.

(i) Solve $\frac{6m-3}{7} = \frac{2m+1}{7}$

(ii) Solve $\frac{3(2a+1)}{4} = \frac{(a+5)}{6}$

Evaluation: The teacher solved the problems and collected their papers for marking.

Assignment: The teacher gives the following exercise as home work for the students to solve: (1) Solve $\frac{3x+5}{7} = \frac{2x-3}{3} - \frac{1}{5}$

(2) Solve $\frac{4t+3}{5} = \frac{t+3}{2}$

(3) Solve $\frac{5e-1}{4} - \frac{7e+4}{8} = 0$

(4) Solve $\frac{2(8x+7)}{3} = \frac{5x}{9}$

LESSON PLAN FOR CONTROL GROUP

LESSON TWO

Date: 18th January, 2021

Subject: Mathematics

Class: JSS II

Average Age: 13 years

Duration: 40mins

Gender: Mixed

Topic: Algebra

Sub-topic: Expansion of Algebraic Expression

Instructional materials: Mathematics Textbook book 2 , workbook, worksheets, pencil, cleaners

Behavioural Objectives: by the end of the lesson the learners should be able to:

(i) Expand given algebraic expression

(ii) Form good attitude of solving problems on expansion

(iii) translate real life problems to algebraic expression

Previous knowledge: The students have been taught fractions, simplification of simple

algebraicproblems in collecting like terms

Introduction: The teacher engaged the students based on the previous knowledge such as; simplify the following fractions

(i) $\frac{2}{3}+\frac{2}{5}$ (ii) $\frac{3}{7}+\frac{4}{5}-\frac{1}{3}$

Presentation: The teacher presents the lesson step by step as follows:

Step I: The teacher guides and facilitates the lesson to the learner by Presenting the following expressions; example

(i) expand the following expression

$(x+2)(x+5) = x^2 + 5x + 2x + 10$

$= x^2 + 7x + 10$

The teacher demonstrates the process of solving this problem above to the learners understanding.

(ii) Expand the expression $(x+2)(x+2)$

Solution: $(x+2)(x+2) = (x+2)^2$

$= x^2 + 2x + 2x + 4$

$= x^2 + 4x + 4$

The teacher explains the process of multiplication and collection of like terms to the students

Step II: the teacher gives the following problems on the board for the Learners' to come one after the other to solve;

(i) $(3x+2)^2$ (ii) $(5x+3)(5x3)$

Step III: The teacher gives the following class work for the students to solve while he moves round to supervise their activities.

Expand the following expressions;

(i) $(5x+7)(5x+7)$ (ii) $(6x+3)^2$

(iii) $(4x-2)(4x-2)$ (iv) $(3x+2)(3x-2)$

Evaluation: The teacher solved the problems in step III with the learners and marked their papers.

Assignment: The teacher gives the following work to the learners as homework;

(i) $(3x-5)(5x+2)$ (ii) $(2x+3)(4x-6)$ (iii) $(6x-3)^2$

LESSON PLAN FOR CONTROL GROUP

LESSON THREE

Date:	25th January, 2021
Subject:	Mathematics
Class:	JSS II
Average Age:	13 years
Duration:	40mins
Gender:	Mixed
Topic:	Algebra
Sub-topic:	Factorization of Algebraic Expression
Instructional materials:	Mathematics Textbook book 2, workbook, worksheets, pencil, cleaners

Behavioural Objectives: By the end of the lesson the learners should be able to:

(i) Factorize the given algebraic expression

(ii) Form good attitude of solving problems on factorization

Previous knowledge: The students have been taught expansion of algebraic expressions such as: $(x+2)(x+5)$, $(x+2)(x+2)$

Introduction: the teacher introduces the lesson by reviewing the previous knowledge on the expansion of algebraic expression such as

(i) $(x+2)(x+5)$

$= x^2 + 5x + 2x + 10$

$= x^2 + 7x + 10$

(iii) Expand the expression $(x+2)(x+2)$

Solution: $(x+2)(x+2) = (x+2)^2$

$= x^2 + 2x + 2x + 4$

$= x^2 + 4x + 4$

Presentation:

Step I: The teacher presents the lesson to the students by solving the following problems and explaining the steps solving the following expressions:

Examples:

(i) Simplify the expression $3y(2x+3y)-2x(2x+3y)$

Solution: $3y(2x+3y)-2x(2x+3y)$

Select the common factor of the above expression and get:

$(3y-2x)(2x+3y)$

(ii) Simplify $3y(4a-5b)-5y(4a-5b)$

Solution: $3y(4a-5b)-5y(4a-5b)$

Select the common factor of the above expression and get:

$(3y-5y)(4a-5b)$

Step II: The teacher writes the following expression on the board for the students to come and solve one after the other;

(i) Factorize the following expression

$= ax(m+n)+rx(m+n)$

Solution: $ax(m+n)+rx(m+n)$

Take common factor in the brackets and resolve others as:

$= (m+n)(ax+rx)$

$= (m+n)(a+r)x$

$= x(a+r)(m+n)$

Step III: The teacher gives the class activity to the students while he goes round to guide and facilitate the lesson

(i) Factorize the expression $x^2 - 4x + 3$

The expected response from the students is as follows:

Solution: factorize $x^2 - 4x + 3$

First put the expression into two common factors as /collect like terms

$(x-1)(x-3) = x^2 - 3x - x + 3$

$= x^2 - 4x + 3$

Evaluation: the teacher gives an assignment the expression $x^2 - 16$ to be factorized

LESSON PLAN FOR CONTROL GROUP

LESSON FOUR

Date:	1st February, 2021
Subject:	Mathematics
Class:	JSS II
Average Age:	13 years
Duration:	40 minutes
Gender:	Mixed
Topic:	Algebra
Sub-Topic:	World problem on Algebraic Expression
Instructional Materials:	New General Mathematics Book 2, work sheet, pencil, biro, cleaners.
Behavioural Objectives:	By the end of the lesson, the learners should be able to: (iv) Translate word problems leading to linear equations. (v) Solve the equation correctly.
Previous Knowledge:	The students have been taught on how to solve linear equations that are not word problem.
Introduction:	The teacher gives the students problem on related previous knowledge for them to solve. (i) Exercise 1: Solve the equation $6x + 5 = 23$ (ii) Exercise 2: Find the value of y in the equation $9 - 3y = 27$
Presentation:	The teacher presents the lesson step by step to solve some examples for students to follow in doing the class work as follows:
Step I:	The teacher presents the lesson on word problems in linear equation to students as examples and he solve them for students to follow him. Example 1: The sum of ages of two brothers is 18 years. If one is 4 years older than the other, find the ages of two brothers.

Examples 2: Suppose the sum of the ages of two students is 22

years. If one of the students is 2 years older than the other, find the ages of the students.

Step II: The teacher gives the students the following activities to solve on their own.

Exercise 1: The difference between five times a number and twelve is 48. Find the number.

Exercise 2: I think of number, I take away 14 and the result is 26. What number am I thinking of?

Step III: The teacher calls on the students, those that know it to come and solve them on the board until the whole problems are solved.

Evaluation: Step IV: The teacher evaluates the students by given them the following work to solve on their note book as class work.

Exercise 1: Find the consecutive whole numbers such that 5 times the smaller number plus three times the greater number makes 75.

Exercise 2: I think of a number and I multiply it by 14 and I add 24 the result is 80. What is the number I am thinking of?

Exercise 3: The sum of four times a certain number and 29 is 89, find the number.

Exercise 4: When a number is added to another four times as big the result is 30. Find the three numbers.

Home Work and Assignment: The teacher gives assignment for students to solve at home as home work.

Exercise 1: The sum of three consecutive natural numbers is 72. Find the three numbers.

Exercise 2: The sum of twice a certain number and 26 is 144. Find the number

APPENDIX L

Oneway

Descriptives

Mean_Performance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Exp1 Problem Solving	165	40.4091	5.31400	.41369	39.5922	41.2259
Exp2 Guided Discovry	165	39.1848	4.68659	.36485	38.4644	39.9053
Exp3 Activity Based	120	39.0875	4.46634	.40772	38.2802	39.8948
Control	150	33.3167	5.11919	.41798	32.4907	34.1426
Total	600	38.0350	5.65158	.23072	37.5819	38.4881

ANOVA

Mean_Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4620.477	3	1540.159	63.254	.000
Within Groups	14511.788	596	24.349		
Total	19132.265	599			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Mean_Performance

Scheffe

(I) Study Groups	(J) Study Groups	Mean Difference (I-J)	Std. Error	Sig.
Exp1 Problem Solving	Exp2 Guided Discovry	1.22424	.54326	.167
	Exp3 Activity Based	1.32159	.59201	.174
	Control	7.09242*	.55668	.000
Exp2 Guided Discovry	Exp1 Problem Solving	-1.22424	.54326	.167
	Exp3 Activity Based	.09735	.59201	.999
	Control	5.86818*	.55668	.000
Exp3 Activity Based	Exp1 Problem Solving	-1.32159	.59201	.174
	Exp2 Guided Discovry	-.09735	.59201	.999
	Control	5.77083*	.60434	.000
Control	Exp1 Problem Solving	-7.09242*	.55668	.000
	Exp2 Guided Discovry	-5.86818*	.55668	.000

Exp3 Activity Based	-5.77083*	.60434	.000

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Mean_Performance

Scheffe[a,b]

Study Groups	N	Subset for alpha = 0.05 1	2
Control	150	33.3167	
Exp3 Activity Based	120		39.0875
Exp2 Guided Discovry	165		39.1848
Exp1 Problem Solving	165		40.4091
Sig.		1.000	.153

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 147.486.

Oneway

Descriptives

Retention

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound
Exp1 Problem Solving	165	65.6485	4.44589	.34611	64.9651	66.3319
Exp2 Guided Discovry	165	58.5091	4.87980	.37989	57.7590	59.2592
Exp3 Activity Based	120	56.7750	4.56781	.41698	55.9493	57.6007
Control	150	44.9267	5.30303	.43299	44.0711	45.7823
Total	600	56.7300	8.98564	.36684	56.0096	57.4504

ANOVA

Retention

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34544.293	3	11514.764	496.586	.000
Within Groups	13819.967	596	23.188		
Total	48364.260	599			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Retention

Scheffe

(I) Study Groups	(J) Study Groups	Mean Difference (I-J)	Std. Error	Sig.
Exp1 Problem Solving	Exp2 Guided Discovry	7.13939*	.53016	.000
	Exp3 Activity Based	8.87348*	.57772	.000
	Control	20.72182*	.54325	.000
Exp2 Guided Discovry	Exp1 Problem Solving	-7.13939*	.53016	.000
	Exp3 Activity Based	1.73409*	.57772	.030
	Control	13.58242*	.54325	.000
Exp3 Activity Based	Exp1 Problem Solving	-8.87348*	.57772	.000
	Exp2 Guided Discovry	-1.73409*	.57772	.030
	Control	11.84833*	.58976	.000
Control	Exp1 Problem Solving	-20.72182*	.54325	.000
	Exp2 Guided Discovry	-13.58242*	.54325	.000
	Exp3 Activity Based	-11.84833*	.58976	.000

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Retention

Scheffe[a,b]

Study Groups	N	Subset for alpha = 0.05			
		1	2	3	4
Control	150	44.9267			
Exp3 Activity Based	120		56.7750		
Exp2 Guided Discovry	165			58.5091	
Exp1 Problem Solving	165				65.6485
Sig.		1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 147.486.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

NPar Tests

Kruskal-Wallis Test

Ranks

	Study Groups	N	Mean Rank
ATTITUDE	Exp1 Problem Solving	165	359.08
	Exp2 Guided Discovry	165	363.23
	Exp3 Activity Based	120	351.81
	Control	150	126.01
	Total	600	

Test Statistics[a,b]

	ATTITUDE
Chi-Square	203.060
Df	3
Asymp. Sig.	.001

a. Kruskal Wallis Test

b. Grouping Variable: Study Groups

FREQUENCIES VARIABLES=Groups school Gender
/ORDER=ANALYSIS.

Frequency Table

Study Groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Exp1 Problem Solving	165	27.5	27.5	27.5
	Exp2 Guided Discovry	165	27.5	27.5	55.0
	Exp3 Activity Based	120	20.0	20.0	75.0
	Control	150	25.0	25.0	100.0
	Total	600	100.0	100.0	

School

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FCE Demonstration Sec. Sch., Okene	165	27.5	27.5	27.5
	Govt. Science Sec. School, Ogaminana	165	27.5	27.5	55.0
	Ihima Community Sec. Sch., Ihima	120	20.0	20.0	75.0
	Govt. Secondary School, Okene	150	25.0	25.0	100.0
	Total	600	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	391	65.2	65.2	65.2
	Female	209	34.8	34.8	100.0
	Total	600	100.0	100.0	