EFFECT OF 5Es INSTRUCTIONAL MODEL AND REFLECTIVE DISCUSSION INSTRUCTIONAL STRATEGY ON ATTITUDE AND ALGEBRAIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN NIGER STATE, NIGERIA

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ABSTRACT

This study investigated the effects of 5Es instructional model and reflective discussion instruction strategy on attitude and algebraic achievement of secondary school students in Niger state. Six research questions were raised and six corresponding null hypotheses were tested at 0.05 significant level. The study adopted a quasi-experimental design (non equivalent control group design) which was carried out in Bida, Minna and Suleja education zones of Niger State. The target population of the study was all the fifty three thousand three hundred and fifty eight (53,358) SS II students in public secondary schools in Niger State. The sample used for the study was three hundred andforty nine (349) SS II students consisting of 68 high ability, 160 medium ability and 121 low ability students from nine intact classes that were randomly selected from the nine secondary schools used for the study. The instruments used for data collection were Algebra Achievement Test (AAT) and Attitude Towards Algebra Inventory (ATAI), which were validated by four mathematics education experts and two psychologists respectively. Lesson plans for 5Es instructional models, reflective discussion instructional strategy and traditional teaching method were developed for the study and validated by mathematic expert. The reliability coefficients of 0.94 and 0.85 were obtained for AAT and ATAI respectively using Pearson Product Moment Correlation and Cronbach Alpha respectively. The research questions were answered using mean and standard deviation while analysis of variance (ANOVA) was used to test the hypotheses formulated at 0.05 significant level. It was observed that there was significant difference in the mean achievement scores among experimental groups and control group (F_{348} = 63.22 with P-Value = 0.0001, P<0.05), it was also observed that there was significant difference in the mean attitude scores among experimental groups and control group (F_{348} = 63.80 with P-Value = 0.0001, P<0.05).Sheffe Post-hoc Test was employed to show the direction of the difference which was observed to be between control and experimental groups The result of the study revealed that 5Es instructional model and reflective discussion instructional strategy were more effective than the traditional teaching method in improving secondary school students achievement and attitude towards algebra. It was recommended among others that teachers should employ 5Es instructional model and reflective discussion instructional strategy in teaching algebra to improve secondary school students' performance and attitude towards mathematics. the study further reviewed that there is no significant difference in mean achievement score among students of different ability level taught algebra using 5Es instructional model (F_{116} = 0.039 with P-Value = 0.962, P>0.05). Similarly the study also revealed that there is no significant difference in mean achievement scores among students of different ability levels taught algebra using reflective discussion instructional strategy (F_{136} = 0.780, with P-Value = 0.460, P>0.05).

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ABBREVIATIONS

A	Agree
AAT	Algebra Achievement Test
ATAI	Attitude Towards Algebra Inventory
ANOVA	Analysis of Variance
BSCS	Biological Science Curriculum Studys
CAPLS	Chemistry Anxiety Rating Scale
D	Disagree
ESTEEM	Expert Science Teaching Educational Evaluation Model
GEFT	Group Embedded Figure Test
GPA	Grade Point Average
MCA	Multiple Classification Analysis
NSES	National Science Education Standard
PPMCC	Pearson Product Moment Correlation Coefficient
SA	Strongly Agree
SD	Strongly Disagree
SPSS	Statistical Package for Social Sciences
SS II	Secondary School Year Two
WAEC	West African Examination Council

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

There is a wide outcry over the level of students' performance in mathematics in Nigeria. This is due to low level mathematics achievement of students in external examination, as reported by Zalmon and Wonu (2017), and Oguguo and Uboh (2020). The poor achievement of students in mathematics is worrisome. A significant area of poor performance in mathematics that was identified and that attracted the attention of students and researchers is Algebra. This is a result of the complex nature of Algebra and as an aspect of mathematics that demands critical thinking, logical and systematic approach.

Algebra is a branch of Mathematics in which letters and other general symbols and signs are used in terms of numbers and qualities in formulae and equations. Adeniji and Ibrahim (2015) described algebra as a branch of Mathematics in which symbols represent numbers of a specified set and area used to represent quantities and to express the general relationship that holds for all numbers of a set. Algebraic expressions serve as models for interpretation and making inferences about data. Algebraic expression and equations are largely involved in physics, chemistry and biology, among others. This indicates that students' overall Mathematics achievement and subsequent applications in today’s world activities largely depend on proficiency in algebraic concepts.

Edwin and Douglas (2018) noted that many students are discontinuing their study of higher-level Mathematics because of their lack of success in Algebra. The application of algebra is important in everyday life as it is a critical tool for the present world of science and technology advancement. Any nation that desires to attain a reasonable

level of development and compete with other nations of the world must ensure that its citizens are proficient in applying algebra concepts to solve everyday challenges. Literature review of studies conducted on causes of students' low achievement in algebra reveals that teachers predominantly adopted the traditional instructional method (lecture method) in teaching algebra. In support of this, Harman and Nguyen (2010) observed that the most widely used and accepted is the lecture method among all strategies. Hassan (2019), reported that the issue of poor performance in mathematics examinations was due to the problem of teaching method. It is in line with this that the federal government declared that a decline in teachers' quality as well as quality of instruction and instructional methods are responsible for students' failure in mathematics (Wushishi *et al.*, 2013).

Conventional teaching methods have been faulted for not yielding results. Oviave (2010) faulted the lecture method in that students are always afraid to ask questions and express their opinions. In a similar effort, Aina (2007) asserted that teaching has gone beyond traditional methods of talk and chalk. Lemo (2014) identified the weaknesses of the conventional instructional method (lecture method), such as it's one-way communication affair which is autocratic and encourages students' passivity. It encourages role learning, it is inappropriate for teaching and encourages students to think for themselves among others. Traditional or conventional teaching method is teacher-centered. The learner is just a passive participant, with no room for questioning, and if there is, little interaction among students is realized.

Scholarly studies have revealed the need for a shift by teachers to instructional methods that are activity-based, which will allow learners to construct their knowledge based on their own understanding. One of these instructional methods that have the potential for effective teaching and learning, is the 5Es instructional model and reflective discussion

instructional strategy. 5Es instructional model was developed by the Biological Science Curriculum Study (BSCS) in 1992 (Alsaid, 2013).

Alebiosu *et al*. (2017) described 5Es model as a learning model consisting of five phases: Engagement, Exploration, Explanation, Elaboration and Evaluation. It is seen as effective hands-on, minds-on and guided enquiry-based scientific pedagogy for enhancing conceptual understanding. Mohammed (2016) also described the 5Es model as an instructional model consisting of five phases: Engagement, Exploration, Explanation, Elaboration and Evaluation, and each phase has a specific function and contributes to the teacher's coherent instruction and the learners' formulation of a better understanding of scientific and technological knowledge.

The engagement phase involved teacher instructing a task, assessing the learners' previous knowledge, and connecting past learning experiences by asking thought-provoking questions. The purpose is to capture students' interest. The teacher can uncover what students know and think about a topic as well as determine their misconceptions. Exploration phase: here the students are provided with co-operative exploration activities, giving them common, concrete experiences that help them begin constructing concepts and developing skills. Explanation phase: learners articulate their ideas in their own words and listen critically to one another. The teachers clarify their concepts, correct misconceptions, and introduce scientific terminology. Elaboration phase: at the elaboration point in the model, some students may still have misconceptions, or they may understand the concepts only in the context of the previous exploration.

Elaborating activities can help students correct their misconceptions and generalize the concepts in a broader context. Evaluation phase: here students' understanding of

concepts and their proficiency with various skills are assessed and evaluated to ascertain their level of progress. Alsaid (2013) stated the following advantages of 5Es instructional model: it takes into account individual differences, introduces progress in knowledge and science as a way of research where the student follows the learning from micro to macro, motivates the student to use his mental processes, it makes learning meaningful and provide the student with many different ways of evaluation. It promotes active, collaborative and inquiry-based learning.

Reflective discussion instructional strategy is a teaching strategy that involves students reflecting upon and interpreting experiences and read or record stories or illustrations. Annetta (2011) defined reflective discussion as an approach where the teacher or student initiates the discussion by asking a question that requires students to reflect upon and interpret films and experiences, and read or record stories or illustrations. Reflective discussion encourages students to think and talk about what has been observed, heard or read. Reflective strategy means looking at what you do in the classroom, thinking of why you do it, and thinking about if it works or not. Reflective discussion is a process of self-observation and self-valuation. It is a means of professional development which begins in our classroom. It is paying critical attention to the practical values and theories which inform everyday action by examining the practice reflectively and reflexively. Annetta (2011) said that reflective discussion encourages students to think and talk about what they have observed and read or heard. As students question and recreate information and events in a story, they clarify thoughts and feelings.

Paula (2009) described the reflective practice as phenomenological, in that a given phenomenon is studied through direct experience, interpreted and the insights gained used to further understand and modify actions. Reflective action involves a willingness

to engage in constant self-appraisal and development. It implies flexibility, rigorous analysis and social awareness. Andrew (2008) gave the following characteristics of reflective practice.

i. Reflective teaching implies an active concern with aims and consequences, as well as means and technical efficiency.
ii. Reflective teaching requires competence in methods of evidence development of higher standards of teaching.
iii. Reflective teaching requires attitudes of open-mindedness, responsibility and wholeheartedness.
iv. Reflective teaching is applied in a cyclical or spiraling process, in which teachers continuously monitor, evaluate and revise their practice.
v. Reflective discussion is based on teacher judgment, informed by evidence-based enquiry and insights from other research.
vi. Reflective teaching, professional learning and personal fulfilment are enhanced through collaboration and dialogue with other colleagues.
vii. Reflective teaching enables teachers to mediate externally developed frameworks for teaching and learning creatively. Figure 1.1. Below shows the key stages of the reflective process.

Reflective discussion serves many purposes. It is used in term of question to stimulate reflection and extend comprehension, challenge students' thinking by inviting them to interpret, infer, summarize, form conclusions and evaluate selection, and extend personal responses by considering the view of others, to share personal thoughts, feeling and images evolved by literature selections, illustrations and experiences. Annetta (2011) used in-class reflective group discussion as a strategy for the development of students as evolving professionals, and reported that the main positive thing about

reflective discussions is that talking with peers can give greater knowledge and perspective on different situations and thought processes, and the feedback is immediate.

Gbemisola (2015) studied the impact of reflective reciprocal teaching on student-teacher's academic achievement and attitudes towards economic and reported positive effects in favour of reflective reciprocal teaching. Literature on the effects of reflective discussion instruction strategy on Mathematics achievement and attitudes towards Mathematics are few, not yet popular and inadequate.

Gbemisola (2015) defined attitude as a psychological tendency expressed by evaluating a particular entity with some degree of favour or disfavour. Ibraheem (2011) noted that poor academic achievement and unhealthy attitudes towards understanding Mathematics have been reported in the literature. The connection between students' attitudes toward and achievement in mathematics has been acknowledged and confirmed many times (Demirel & Dagyar, 2016). Various research reports indicated that higher achievers tend to have more positive attitudes toward Mathematics. Students' attitudes toward Mathematics determine their level of engagement, the quality of their learning and their performance. It is in line with this, Evans (2011) stated that attitudes towards Mathematics are significant due to the reciprocal relationship between attitudes towards Mathematics and achievement in Mathematics.

Also, a study by Okeke (2011) reported that senior secondary school students often exhibit a poor disposition towards Mathematics. Students' poor disposition towards Mathematics confirms that Mathematics teaching in Nigeria has not only been properly done but bedevilled with several problems (Awofola & Nneji, 2012). Students have continued to display negative attitudes towards the learning of Mathematics largely because teachers have continued to adopt ineffective instructional strategies. This is

confirmed in a research report by Awofala and Awolola (2011), who observed that students' negative attitudes towards Mathematics achievement is partly due to their resistance to change in methods of instruction.

Achievement refers to learning skills attained by a learner in a particular subject, it is measured by a numerical score obtained in a test. Gbemisola (2015) observed that achievement could be influenced by students' background, ability, interest, environment, motivation and teaching methods. Several research reports revealed that teaching methods used by a teacher have significant effects on students' achievement and attitude irrespective of ability level. Students are generally classified into high, medium and low ability levels based on numerical scores when subjected to a particular learning task.

Research on more effective instructional methods that could bridge the gap of achievement among students with different levels of academic achievement has been neglected or not properly given attention (Gbemisola, 2015). The present research intends to examine the effects of 5Es Model and Reflective Discussion Instructional Strategies on Algebra Achievement and Attitudes of Secondary School Students in Niger State.

1.2 Statement of the Research Problem

The low achievement of students in mathematics has persisted in Nigeria. Studies available have shown efforts geared towards improving this achievement through appropriate teaching methods, yet the achievement of secondary school students in mathematics, particularly algebra, is yet to produce the expected outcome.

The recent results of secondary school students in Mathematics presented by West African Examination Council (WAEC) in Chief Examiners Report Shows that in 2013,

2014, 2015, 2016, 2017 and 2018 only 36.00%, 31.30%, 34.18%, 38.68%, 59.20% and 33.33% respectively obtained credits in Mathematics, this indicates that in 2013 to 2018 an average of less than 50% of the total population of student that registered and sat for the examination passed at credit level (WAEC, 2013-2018), see App G. This ugly situation need to be salvaged. The search light is on a better instructional strategy.

Several strategies were employed to improve students' performance in mathematics in Nigeria; among these strategies are concept mapping, computer-assisted instruction, cooperative learning, and discussion method. However, these teaching methods have not produced satisfactory results (Hassan, 2019). The need for effective mathematics teaching strategy becomes necessary. Several studies (Gokhan, 2016; Hamdani, 2013; Khaled, 2016; Tuna, 2013; Biber & Tuna, 2015; Madu & Ezeamagu, 2013), among others, have been carried out, validated and discovered learning cycles to be effective in teaching and learning mathematics globally. However, despite the wide spread application of learning cycles, particularly 5Es, to improve mathematics classroom instruction in many western countries and Nigeria, literature appears to suggest that there is limited research that specifically examines secondary school students' mathematics achievement and attitude employing the 5Es model in the African context, Nigeria in particular. Similarly, other studies such as (Annetta, 2011; Gbemisola, 2015; Laura, 2018; Mevlut & Ahmet, 2022) have been conducted and reported the effectiveness of reflective teaching in English classes, particularly in communication skills, there is no enough evidence that reflective discussion has been tested on mathematics achievement. Considering the above, it is pertinent to state that the 5Es Instructional model and reflective discussion instructional strategies are under-researched in Algebra. Based on this, the researcher argues that the teaching of algebra could be improved using the 5Es instructional model and reflective discussion

instructional strategy rather than the traditional method. A positive attitude towards algebra could be achieved when appropriate instructional strategies are used in classroom teaching and learning. A positive attitude is developed when learning is students-centred, activity based and hands-on activities. In view of the above, the present research laid emphasis on secondary school students' attitudes and achievement as the poor achievement of learners in mathematics, algebra in particular, has been a topic of concern over the past decades.

Issues on ability levels are inconclusive. Ability levels implication especially as it affects learning, needs more verification. This prompted the present research on the effect of the 5Es instructional model and reflective discussion instructional strategy on the algebra achievement and attitude of senior students in Niger State. Therefore, the problem of the study put in question form is would 5Es instructional model and reflective discussion instructional strategy improve students' achievement and attitude in algebra in Niger State?

1.3 Aim and Objectives of the Study

This study aims to examine the effects of 5Es model and reflective discussion instructional strategies on mathematics achievement and attitude of secondary school students in Niger State. The specific objectives of the study are to examine the:

i. Effects of 5Es instructional model and reflective discussion instructional strategy on Algebraic Achievement of secondary school students in Niger State.
ii. Effects of 5Es instructional model and reflective discussion instructional strategy on secondary school students' attitude towards Algebra in Niger State.
iii. Effect of 5Es model on Algebraic Achievement among secondary school students of different ability levels in Niger State.

iv. Effect of 5Es model on attitude towards Algebra among students of different ability levels in Niger State.
v. Effects of reflective discussion instructional strategy on Algebraic achievement among secondary school students of different ability levels in Niger State.
vi. Effects of reflective discussion instructional strategy on attitude toward algebra among student of different ability levels in Niger State.

1.4 Research Questions

The following research questions were raised to guide the study:

1. What is the difference in the mean achievement scores among secondary school students taught algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method?
2. What is the difference in the mean attitude scores towards Algebra among secondary school students taught using 5Es instructional model, reflective discussion instructional strategy and lecture method in Niger State?
3. What is the difference in the mean achievement scores among secondary school students of different ability levels when taught using the 5Es instructional model?
4. What is the difference in mean attitude scores towards Algebra among secondary school students of different ability levels taught using the 5Es instructional model?
5. What is the difference in the mean achievement scores among secondary school students of different ability levels when taught using reflective discussion instructional strategy?
6. What is the difference in mean attitude scores towards Algebra among secondary school students of different ability levels taught using reflective discussion instructional strategy?

1.5 Research Hypotheses

Based on the stated research questions, the following null hypotheses were formulated and tested at a 0.05 level of significant.

Ho_1: There is no significant difference in the mean achievement scores among secondary school students taught Algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method in Niger State.

Ho_2: There is no significant difference in the mean attitudes scores towards Algebra among secondary school students taught using 5Es instructional model, reflective discussion instructional strategy and lecture method in Niger State.

Ho_3: There is no significant difference in the mean achievement scores among secondary school students of different ability levels taught Algebra using 5Es instructional model in Niger State.

Ho_4: There is no significant difference in the mean attitude scores towards Algebra among secondary school students of different ability levels taught using the 5Es instructional model in Niger State.

Ho_5: There is no significant difference in the mean achievement scores among secondary school students of different ability levels taught Algebra using reflective discussion instructional strategy in Niger State.

Ho_6: There is no significant difference in the mean attitude scores towards Algebra among secondary school students of different ability levels taught using reflective discussion instructional strategy in Niger State.

1.6 Significance of the Study

The purpose of this study is to examine the effects of the 5Es model and reflective discussion instructional strategies on the attitude and Algebraic achievement of secondary school students in Niger State, Nigeria. It is expected that findings from this study will be of significance to the following groups of people: the students, teachers, educational administrators, curriculum planers, and researchers, among others. Findings from this study will provide students with relevant skills for learning Mathematics, which could improve their performance in Mathematics and improve their positive attitude towards Mathematics.

Mathematics teachers' content and pedagogical knowledge will be improved, which will lead them to conduct effective instruction and improve their productivity. It will encourage teachers to organise an interactive class, focused on their students thinking and understanding of concepts and hands-on activities. Teachers' role in the class will be that of facilitator. This will reduce teachers' work and stress in the classroom. Also, teachers will have access to different teaching methods that are expected to yield a positive result on students' achievement in Mathematics.

Educational administrators will find the work significant as it will improve and boost their teachers' effectiveness and students' performance in mathematics in general. The administrators will encourage the use of different teaching methods, including the 5Es model and reflective discussion in their various schools or institutions.

Curriculum planners will also benefit from this study by advocating the use and inclusion of the 5Es model and reflective discussion methods in the Mathematics curriculum. Planners will emphasise the pedagogical and content knowledge of Mathematics teachers at our secondary school level. This will go a long way to

strengthen the effective teaching and learning of Mathematics. It will add to the efforts made by researchers and Mathematics educators to make Mathematics teachers see the need for more helpful and effective methods of teaching Mathematics. It will provide a relevance base of reference for researchers and Mathematics educators. It will boast the performance of secondary school students in algebra.

1.7 Scope of the Study

This study covered senior secondary schools in Niger State. All the SSII students in Niger State formed the population for the study. The study aimed at investigating the effects of the 5Es model and reflective discussion instructional strategy in teaching Algebra to students with a view for improving their achievement and attitude toward Mathematics. The geographical scope of this study is Niger State of Nigeria, Niger State is in the North Central of Nigeria, with Minna as the State capital. It has an area of 76.363 $km^{2,}$ which lies on latitude $10^{0}21'55''$ North and longitude $5^{0}39'$ 40'' E.

Niger State is among the six north central states of Nigeria and falls within the meddle-belt zone. Selected senior secondary school year two (SS II) students in Niger State formed the population for the study. The choice of SS II students was based on the fact that they had covered some contents on Algebra and are not pre-occupied with any major or external examination. The content scope of the research is limited to Algebra. From the literature, it has been observed that many students are discontinuing their study of higher-level Mathematics because of their lack of sound knowledge and success in Algebra. The West African Examination Council (WAEC) Chief Examiners report has continuously revealed weak performance of students in algebra aspect and misinterpretation of Mathematics problems as factors causing poor performance of students in Mathematics. The independent variables are the 5Es model and reflective

discussion instructional strategies, while the dependent variables includes students' mathematics achievement and attitude toward mathematics; the moderating variable is ability levels. One week was used for a preliminary survey and introduction and administering pre-test to subjects in the schools. Six weeks was used for giving treatments and one week for administering the posttest and collection of results. Therefore, the study covered a period of eight weeks.

1.8 Operational Definition of Terms

5Es Model: This is an instructional model that consists of five phases: Engagement, exploration, explanation, elaboration and evaluation in teaching algebraic expression

Reflective Discussion: It is an instructional strategy where the teacher or students initiate the discussion by asking a question that requires students to reflect upon and interpret read items.

Achievement: Gained obtained in terms of the score on mathematics concepts taught.

Attitude: Students' behaviour toward mathematics expressing their degree of favour or disfavour.

Ability Level: Grouping students according to their levels of achievement.

Low Ability Level: These students obtained a score of 0 – 49 percent on Mathematics achievement tests.

Medium Ability Level: These are students who obtained a score of 50 – 59 percent on Mathematics achievement tests.

High Ability Level: These students obtained a score of 70 percent and above on Mathematics achievement tests.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

Conceptual framework defines the relevant variables for a study and maps out how the variables might relate to each other. In this study, the independent variables are the 5Es instructional model, reflective discussion instructional strategy and traditional teaching method. The dependent variables are algebra achievement and attitude towards algebra, while the moderating variable is student ability. It is shown in figure 2.1.

Diagrammatical representation of conceptual framework

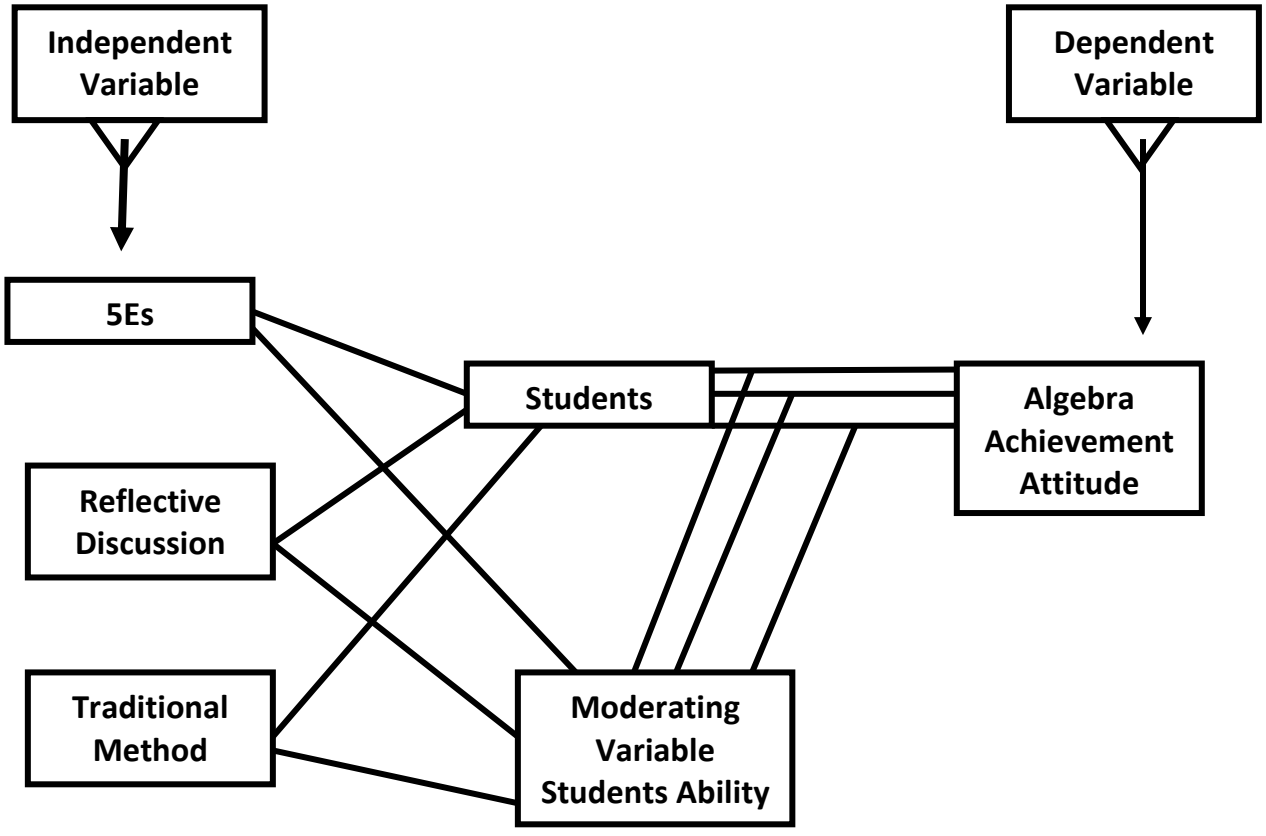

Figure 2.1: Diagrammatical representation of conceptual framework

Source: Researcher, 2023

Figure 2.1 Shows the conceptual framework of this study which was derived from a review of relevant literature. The independent variables include the 5Es instructional model, reflective discussion instructional strategy and traditional teaching method, which will be manipulated to determine the effects on the dependent variables, including algebra achievement and attitudes. Findings from the literature indicated that algebra is a difficult and abstract concept to learn, and one's attitude could enhance performance positively or negatively. The moderating variable in this study is students' academic ability; academic ability is a psychological issue which are yet inconclusive. It's implication especially as it affects achievement and attitude in algebra, needs more verification.

2.1.1 History of 5Es instructional model

5Es instructional model is traced back to the ideas of Johann Friedrich Herbart, John Dewey, J. Myron Atkin, and Robert Karplus (Cynthia, 2017). Herbart's work dates back to the beginning of the 20th Century, involving two main components to Herbart's philosophy of teaching: interest and conceptual understanding. His philosophy was among the first approaches to teaching that resemble a learning cycle where students will first discover and connect to prior knowledge or experiences. Secondly, the teacher would guide them through experiences to further make connections. Lastly, the student would have to take what they have learned and apply their new knowledge to a new experience.

John Dewey was from the school of thought that learning should be hands-on and minds-on. The final learning cycle to preclude the 5Es instructional model was the Science Curriculum Improvement Study (SCIS) developed by Robert Karplus and J. Myron Atkins in the late 1950s through the early 1960s. Karplus was a theoretical

physicist, but he applied Jean Piaget's philosophy of learning to science instruction. Atkins shared Karplus' idea of teaching but applied his ideas about instructing science to elementary age students. The two collaborated and developed the Atkin-karplus learning cycle. The learning cycle was composed of three phases: exploration, invention and discovery. The 5Es instructional model was developed by the Biological Science Curriculum Studies (BSCS) in the 1980s. Cynthia (2017) provides five stages of the 5Es instructional model to learning in the following order: engagement, exploration, explanation, elaboration and evaluation. The stages are defined as follows:

Engage

The engagement phase involved teacher instructing task, assessing the learners' previous knowledge, and connecting past learning experiences by asking thought-provoking questions. Teacher stimulates students' prior knowledge. This knowledge may or may not be in harmony with the concepts presented. This stage provides the opportunity for teachers to find out what students already know or think the know about the new concept to be taught. It captures students' interest and encourages them about the topic and concepts. Here, the teacher poses questions about what his/her students already know, and students pose questions about what they want to learn. This will alert the teacher of misconceptions.

Explore

Here, students are provided with cooperative exploration activities, giving them common, concrete experiences that help them begin constructing concepts and development of skills. At the exploration stage, students are involved in activities to explore the topic. Students are involved in short readings and generate their own set of testable questions. The students are engaged in critical thinking about the concepts by experimenting, investigating, observing, classifying, communicating, measuring,

predicting and interpreting. It leads students to discover new ideas, skills and confirm prior assumptions.

Explain

This is an opportunity for the teacher to introduce the content to the students. The teacher gives students time to think and facilitates student-student discussions to correct misconceptions. It is a time to question and provide answers. The learners articulate their ideas in their own words and listen critically to one another. The teacher clarifies their concepts, corrects misconceptions and interprets the activities of the previous phases. Learners are guided to put down observations, questions and learnt skills into simple language.

Elaborate

Here students make connection between prior knowledge and new experience. The teacher help students compare, contrast combine, synthesize, generalize and make inferences. The students apply new knowledge, make connections and extend ideas. The experiences gained by learners in the previous phases are extended to real situations. The teacher introduces new information that is linked to what the learners have learnt during their activities.

Evaluation

At the evaluation stage, teachers evaluate students to see if they have achieved the instructional objectives. Researchers of 5Es model reported the effectiveness of the 5Es model and recommended its usage and to improve on it. The figure below represents 5Es model of teaching.

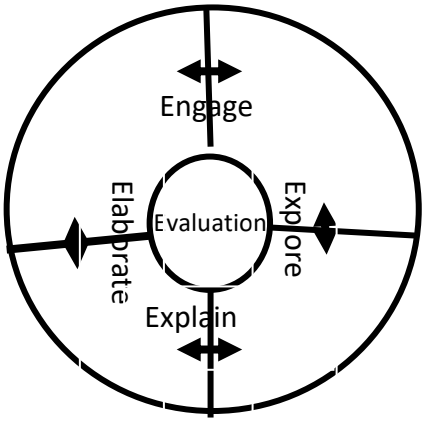

Figure 2.2: Model of 5Es

Source: BSCS (2011)

The 5Es teaching model represents a recursive cycle of cognitive stages in inquiry-based learning as indicated above.

2.1.2 Concept of reflective discussion

In the last few decades, reflecting learning has come into the education spot light. Laura (2018) defined reflective learning as involving students thinking about what they have read, done or learned, relating the lesson at hand to their own lives and making meaning out of the material. It is more than just memorizing some facts, formulas, or data. Reflective practice is the ability to reflect on one's actions so as to engage in a process of continuous learning. It involves "paying critical attention to the practical values and theories which inform everyday actions, by examining practice reflectively and reflexively.

A key rationale for reflective practice is that experience alone does not necessarily lead to learning; deliberate reflection on experience is essential. Reflective practice is the process of looking at your actions in order to gain professional experience. Professionals in many practice-based fields, including nursing, teaching and management, use this concept to develop professional expertise. In the field of education, reflective practice is often called reflective teaching/learning. Donald Schon first formally introduced it in 1983 with his seminal text "the reflective practitioner"

(Marzano, 2012). Marzano (2012) identified some common areas of teaching that instructors may reflect on; these include;

i. The assumptions underling teaching and learning
ii. The appropriateness and/or effectiveness of instructional decisions.
iii. Improving actions in a particular course.
iv. Generalized knowledge or approaches to teaching.

Reflective discussion has many advantages, these are among others

i. Accepting responsibility for your learning and, as a result, for your personal growth.
ii. Becoming meta cognitive, or aware of your internal thinking processes.
iii. Becoming aware of your motives with your actions
iv. Being a link between the work you are putting into learning and what you are getting out of it.

2.1.3 Traditional methods of mathematics instruction

Traditional methods of Mathematics Instruction, also known as conventional teaching, are described as a method involving asking learners to open the textbook, read the passage, and answer questions. The teacher is the centre of the lesson, the students receive the instruction and may do some supporting activities along the way. Here, concepts are taught in isolation rather than as only a part of a more complex project. In the traditional method, students are passive recipients of the teacher's information.

Studies show that their knowledge deepens when students are fully engaged in defining the problem and looking for a solution. They will be able to understand the many facets of the topic much more fully. The traditional method of teaching, which is still the norm used by teachers in Nigerian Secondary Schools, has the following weaknesses: it is a

one-way communication affair which is autocratic, encourages students' passivity, it encourages role learning and encourages students to think for themselves (Lemo, 2014). Despite these, Festus (2013) reported that Mathematics teaching still follows the traditional pattern, where teacher-directed instruction is used to present materials for new lesson. Emphasizes is now on shift by researchers to instructional strategies that are activity-based.

2.1.4 Role of mathematics and it's application

Maursund (2010) defined mathematics as making conjunctions, seeking relationships, validating theories, searching for solutions, verifying results, communicating, finding in words, and problem-solving. The role of Mathematics cannot be over-emphasized. It serves as a critical role in the development of human capital in science, technology, engineering and other key sector of the economy.

Sayan (2015) posited that Mathematics education provides individuals with perceptive and knowledge to understand the world and enhance their social interaction and their skills. In line with this, Owolabi and Adeniji (2017) asserted that the knowledge and basic skills provided by mathematics help to analyze various experiences, solve problems systematically, facilitate creative thinking and aesthetic development, as well as development of reasoning ability and skills of individuals in various situations of life. Mathematics is a compulsory subject at both primary and secondary school levels, a basic requirement for admission into tertiary institutions in Nigeria and a requirement for reading some professional courses such as medicine, engineering, and architecture. It is the building block for everything in our daily lives, including electronic and mobile devices, engineering, carpentry, designs, architecture, art and even sport. This is why society recognises mathematics as the foundation of scientific and technological

knowledge that is significant in socio-economic development of the nation. It is based on these Otunu and Ukpeloor (2013) noted that functional Mathematics education is the agent of transformation in this technological age. Tsahfe and Yusshau (2014) also stated that Mathematics is important in all human endeavours, as such, cannot be thrown overboard in every human decision to be taken, a project to be executed, policy to be implemented, or any study to be carried out.

The role being played by Mathematics in day to day activities of man is suggestive of the fact that Mathematics is needed by all, not only for scientific or technological development but also for all forms of development (Eze, 2010). In support of this, Alhassan et al. (2015) Observed that Mathematics is needed for the technological development of Nigeria and that the future of national industrial and technological development hinges on Mathematics, which is regarded as the pillar of science and technology. In support of this, Awofala and Nneji (2012) stated that Mathematics as a creation of the human mind is the language of precision and whetstone of creativity thinking and problem-solving needed essentially to bring harmony, exactness, compactness and accuracy into the knowledge of science, technology, and engineering and their products. In similar efforts, Okeke (2011) asserted that Mathematics education is the practice of teaching and learning of Mathematics to solve problems involving learning algorithms and formulas necessary for computation.

The position of Mathematics in the modern period of technological development in the world is wide and profound, in accordance with this reasoning, Okigbo (2012) emphasized the important of Mathematics knowledge as the science that deals with the logic of shape, quality and arrangement. Mathematics embraces many important ideas about numbers and shapes, powerful means of communication, and the science or practice of transmitting information into symbols and signs. It is obvious that

Mathematics is the key factor to national development; without it, developing countries, including Nigeria, may not attain the desired level. Mamman and Eya (2017) posited that the Nigeria vision 20:2020 might not be realized as planned unless urgent steps are taken to improve performance in Mathematics. They further stressed that Mathematics serves as critical role in developing human capital in science, technology, engineering and other key sectors of the economy. It is based on these science educators have directed efforts towards improving students' achievement and attitude in Mathematics.

2.1.5 Students' attitudes towards learning of mathematics

Attitude forms a central part of a person's identity. Attitudes are defined by Gerrie (2017) as manners of acting, feeling, or thinking that show one's disposition or opinion. Attitude changes more slowly than emotions and changes more quickly than beliefs. Attitude may involve positive or negative feelings, which are felt less intensely than emotions. Cooke (2015) asserted that the enjoyment of mathematics could be regarded as a positive learning disposition, as it contains built-in elements such as the "desire, enthusiasm, confidence, and willingness, not out of necessity," to indulge in mathematical tasks or challenges. The quality of mathematics teaching and teachers' attitudes seem to greatly influence students' attitude towards mathematics and their achievement. Yara (2009) confirmed that teachers with positive attitudes towards the subject also stimulate favourable attitudes in their students.

Sloan (2010) focused her research on pre-service mathematics teachers and discovered that teachers who are not really comfortable with the subject area usually have less positive attitudes towards mathematics preferably teach procedurally, and generally tend to focus less on mathematical concepts, reasoning and problem-solving strategies. In support of this, Akay and Boz (2010) reported that students have continued to display

negative attitudes toward the learning of mathematics largely because teachers have continued to adopt ineffective instructional strategies. Evans (2011) reported a significant relationship between attitude and achievement in mathematics. Positive attitudes towards mathematics enhanced better achievement in mathematics. Also, Ibraheem (2011) noted that poor academic achievement and unhealthy attitudes towards understanding mathematics have been reported in the literature. The connection between students' attitudes towards achievement in mathematics has been acknowledged and confirmed many times (Demirel & Dagyor, 2016).

On the other hand, several researchers, such as Ajili and Imoko (2015) and Hassan (2019), have observed the effects of planned teaching methods on learners' attitudes towards Algebra in Nigeria. None of these studies investigated the efficiency of such methods on learners' attitudes towards algebra. This is in line with the result of Awofala *et al* (2013) who observed that one reasonable clarification for the above statement is the evaluation approaches of learners' learning mathematics are repeatedly tailored towards the direction of the attainment of cognitive skills with little or no inclination for effective skills, this implies that attitude as a key concept in the affective domain is not often evaluated in secondary schools mathematics examination. However, instructional strategies in mathematics education are examined with the hope of refining learners learning outcomes (Sun & Herman, 2018).

A study by Mata *et al* (2012) investigated how certain adverse but interconnected variables like back ground, motivation, and social support can lead to clarification of learner attitudes towards mathematics and understanding of the defining features of these attitudes in the school environment. The study adapted intrinsic motivation inventory as the instrument for data collection.

The sample of the study consisted of 1719 Portuguese students selected from fifth-to-twenth grade. One unit of the questionnaire named (in my math class) measures students' perception of teachers and peer support as well as students' attitudes. The findings indicated positive attitudes towards mathematics.

Awofala *et al.* (2013) carried out a study to find out the impact of Framing and Team Assisted Individualized (TAI) instructional methods. The study employed 3 x 2 x 2 factorial matrix with a population of 350 senior secondary SS II students in Nigeria (172 males and 178 females) revealed a significant main effect of treatment and gender on attitudes means score of subjects exposed to the TAI method. Mato and De La Torre (2010) asserted in their work that secondary school students with improved academic achievement had a positive attitude to mathematics than students with weak academic achievement.

2.1.6 Achievement in mathematics

Achievement refers to a thing done successfully with skill, courage or effort. It is something which someone has done successfully after much effort. Achievement is an aspect of measuring the effects of relatively standardized sets of experience (Anastasi & Uiana, 2009). This work focuses on academic achievement. Academic achievement is the level of proficiency and knowledge demonstrated by an individual after learning has taken place. The current and most commonly used parameter for verifying the extent of learning that has occurred or the level of proficiency of an individual is scores and GPA obtained through teacher-made tests, examinations or standardized tests.

Mathematics Achievement is a very important issue in Nigeria. Yet, it has been in a soury state for more than twenty years. Mathematics achievement has been very low, slow and frustrating. This poor trend of achievement in mathematics is made obvious in

research work reported by Zalmon and Wonu (2017). The study indicated that in 2013, 2014, 2015 and 2016, the total population of students who registered and sat for General Mathematics conducted by the West African Examination Council (WAEC) only 36.00%, 31.30%, 34.18% and 38.68%, respectively passed at credit level (A1 – C6). This ugly trend of low academic achievement in mathematics over the years is now a national issue. Mathematics educators have been intensifying the efforts devoted by researchers to exploring characteristics of teachers and other factors in Mathematics teaching and learning so as to improve students' mathematics achievement, indicates that a search light most be thrown on the instructional approach employed by Mathematics teachers.

2.1.7. Concept of ability level in mathematics

Three heterogeneous ability levels have been identified; these are low achievers, average or medium achievers and higher ability level. According to the rationalist ideal, the practice facilitates teaching and learning by enhancing both teachers' and students' adjustment. Adeniji (2015) stated that if those in the medium and low-ability groups are identified, teachers and the school system can give more attention and provide interaction programs for them.

Ability grouping is the practice of grouping children together according to their talents in the classroom. Proponents of ability grouping argued that the practice allows teachers to tailor the pace and content of instruction much better to students' needs and, thus, improve students' achievement. There is a long-term debate as to the effectiveness of homogeneous versus heterogeneous grouping within the classroom. Homogeneous grouping or ability grouping refers to the practice used by teachers to provide differentiated instruction for students based on the level at which they have mastered

specific skills. In heterogeneous grouping, students interact and learn from each other since they are purposely mixed due to their differing levels of academic achievement.

Some schools and systems have taken it to the length of grouping students in specific classes based on their abilities, while others consistently mix students. The findings of the research are inconclusive. Berends and Donoldson (2011) conducted research to compare ability groups between traditional and charter schools. To determine the types of grouping used in traditional and charter school classrooms, surveys were taken in rural, urban and suburban areas across 24 states. Traditional public schools were method to charter schools based on grade range, real ethnic and socioeconomic composition, initial achievement scores and proximity. The conclusions simply stated that neither charter schools ability groups nor traditional school ability groups significantly affected student achievement in Mathematics.

Another mixed-method study was conducted by Gess (2011). It was a three-year study, 3eight grade students and 5 middle school teachers participated. Students' achievement was analyzed through ITBS standardized scores. The test scores encompassed their sixth, seventh, and eight grade years. The variance of the scores was analyzed using the ANOVA. Surveys and interviews were conducted to identify student and teacher opinions of the different ability groups. Gess (2011) states, “A cross-sectional survey and focus group interview” helped to identify attitudes towards grouping type. Based on the ANOVA, there was no statistical significance between student scores on the IOWA Test of basic skills. Because of the liken scale used on the survey, the researcher identified quantitative data from the results 100% that ability grouping was important for effective learning. Gess (2011) stated that there is potential for negative labelling among students when ability groups are implemented, and based on statistical analysis,

findings suggest that all benefits of ability grouping may not be measurable through standardized tests or other academic measures.

2.2 Theoretical Framework

The theories behind the learning circle and reflective discussion can be considered under constructivism and inquiry.

Constructivism is a theory based on how people learn. It is a learning theory based on learners constructing their own learning from prior knowledge and past experiences. Literature has indicated that constructivist learning is of two types: cognitive and social constructivism. In order to have an effective constructivist classroom, teachers should have an understanding of both cognitive and social constructivism (Powell & Kalina, 2009).

Jean Piaget is regarded as the father of cognitive constructivism. The premise of cognitive constructivism is that student learn through constructing their own knowledge. Piaget propounded four stages of development: Sensory-motor, preoperational, concrete operational and formal operational. Piaget believed that a child's learning is based on assimilation and accommodation as a child progresses through the four stages (Powell & Kalina, 2009).

Piaget's four stages are dependent upon the age of a child. The sensory-motor stage is from birth to the age of 2 years. During this period, a child discovers their surroundings through their senses. From the age of 2 years to 7 years, a child is in the preoperational stage. Here, children are developing language skills but cannot synthesize others' thoughts. Concrete operational is the stage between 7 to 11 years during which children begin to develop logical reasoning. The last stage of development is the formal

operational stage which lies between 11 years and adulthood. This is the time for critical and abstract thinking. Although Piaget's development theory has been criticized because it was developed based on his children, it is highly respected among theories. Cynthia (2017) itemized the characteristics of the constructivist class as follows;

1. Learners are activity involved.
2. Environment is democratic.
3. Activities are interactive and student-centred.
4. The teacher facilitates a learning process in which students are encouraged to be responsible and autonomous.

The constructivist learning theory framework holds that learning is propagated upon knowledge that a student already has. It suggests that learning is more effective when a student is actively engaged in the learning and interacting process outside the classroom rather than passively attempting to receive knowledge. Here learners become active participants based on their previous experiences and interactions with others to construct new understanding and knowledge.

Social constructivism is the second type of constructivist learning. Lev Vygotsky is the leading pioneer of social constructivism. This theory is based on learners interacting and collaborating with one another. A classroom that models Vygosky'spheories has high social interaction, allowing learners to develop language skills and content knowledge. Although these theories are different, they agree that the classroom should not be teacher-centred but rather learner-centred. The teacher should act as a facilitator of learning and guide learners to discover new knowledge based on their prior knowledge and experiences. Constructivism was defined by Mohammed (2016) as a process of interaction between three elements in the educational attitude: post experiences, the

educational attitude presented to the learner, and environmental climate in which the learning process takes place to build and develop new knowledge structures, characterized by inclusiveness comparing to the previous knowledge, and using these new cognitive structures in addressing new environmental attitudes. The constructivist theory emphasises on learning rather than teaching, regarding learners as creative students and encouraging them to be independence, take initiative, research, investigate, and discuss, as it encourages curiosity to learn, and creative thinking to build new knowledge and change the teacher's role to interactive teacher, organizing the learning environment, while the learner role is activity based and positive innovation, and try to discover knowledge.

2.2.1 Constructivism and 5Es instructional model

5Es is one of the constructivist models, which was developed by Rodger W. Bybee in 1997, consisting of five stages: engagement, exploration, explanation elaboration and evaluation (Adshehri, 2016). The objective in a constructivist strategy is to encourage students' current conceptions by providing data that links with students' current thinking or experiences. Evidence of constructivism in 5Es model is observed in the five phases. In the engagement phase, the student's prior knowledge of a concept is elicited and linked to present and future topics. At this stage, student ideas are used to build interest. While exploration and elaboration-hands on activities occurs, learning here becomes interactive and sharing ideas among learners becomes effective. At the explanation phase, direct instruction by the teacher and interaction with learners commence. Evaluation is continuous; the learners are evaluated at different stages.

2.2.2 Inquiry and learning circle

According to the National Science Education Standard (NSES, 1996) (Cynthia, 2017), inquiry is a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire, knowledge and develop a reach understanding of concepts, principles, models and theories. Much of the research related to inquiry science has been focused on student outcomes and behaviour and the roles and feelings of teachers as they have encountered the radical method of instruction. Asan instructional model, the learning cycle provides the active learning experiences recommended by the National Science Education Standard Curriculum designed around levels of inquiry and provides a rich context for implementing the 5Es model of instructional practices. Inquiry-based learning is a means of constructing knowledge through collaborative and communicative processes. Learners are encouraged to develop and inspire term work to come up with collective decision through knowledge sharing. The foundations of the model are based on constructive theory. It is an approach to learning that stresses the students' role in the learning process. Teachers use questions, problems, and environment to encourage students to learn through individual experiences. Steps in inquiry-based learning are Understanding the problem, make a plan, carry out the plan, and look back and reflect. Characteristics of inquiry-based learning include;

1. Learners develop questions that they are hungry to answer.
2. Research the topic using class time.
3. Students present what the have learned.
4. Students reflect on what worked.

About the process and what didn't work (https"//www.edutopia.org,biog.w....)

2.2.3 5Es as an inquiry based

Inquiry based learning in a classroom setting can be addressed through the 5Es learning cycle model. The characteristics of the inquiry based learning model are observed in the phases of the 5Es model. At the engagement phases, learners are motivated by thought-provoking questions that they are eager to answer through their prior knowledge. At the exploration and elaboration phases, students are engaged in collaborative activities, present what they have learned and share experiences gained. The students reflect on what they have learned and evaluation takes place by the teacher.

2.2.4 Reflective discussion method

Annetta (2011) posited that reflective discussion is linked with critical social theory, which is itself connected to adult learning, experiential learning and transformational learning. Critical social theory provides a framework by which changes and emancipation in the pedagogical process can occur through reflection, critique, analysis, giving consideration to culture and context, from one knowledge transmission to knowledge transformation (Annetta, 2011). In support of this, Gbemisola (2015) asserted that reflective discussion method is based on social constructivist approach to teaching and learning and the cognitive learning theory as articulated by Kolb and Vygoky. The constructivist philosophy emphasized learners active involvement in the process of thinking and learning. Constructivism is a philosophy that emphasizes the dynamic role of learners in constructing and making sense of information. In the present study, the constructivist approach was adopted. Participants were expected to become more actively involved in building their own understanding as they interact with each other and any other learning tool. These two methods are expected to generate a more learner centered environment.

2.3 Empirical Study

2.3.1 Previous studies using 5Es model

Several studies have reported that the 5Es learning model is an effective method of instruction for increasing scientific understanding as compared and opposed to a more traditional style of teaching. The 5Es learning cycle has been proved to help alleviate students' misconceptions. Cynthia (2017) conducted a research purposely to determine if students' chemistry knowledge and interest can be increased by using the 5E learning cycle in a middle school with a high population of English language learners. The participants were eight-grade middle school students in a large metropolitan area. Students participated in a month-long chemistry unit. The study was a quantitative, quasi-experimental design with a control group using a traditional lecture style teaching strategy and an experimental group using the 5E learning cycle. Students completed a pre-and post-students attitude in science surveys, a pretest, post-test for each mini-unit taught and completed daily exit tickets using the expert science teaching educational evaluation model (ESTEEM) instrument to measure daily students outcomes in main idea, students inquiry, and relevancy. Analysis of the data showed that there was no statistical difference between the two groups overall, and all students experienced a gain in content knowledge overall. All students demonstrated a statistically significant difference in their interest in science class, activities in science class and outside of school. Data also showed that scores in writing the main idea and writing inquiry questions about the content increased over time.

Abo-Safr (2014) study aimed to know the effect of the employment of two strategies, quintet learning cycle (5E's) and self-Table (KWL) in the development of Mathematical problem-solving skills at the eighth-grade students in Gaza Governorates, Palestine. The

study used a semi-experimental approach and applied study on a sample of 94 female students who were divided into three groups: two experimental groups consisting of (32) students each, each group studied with one of the employed strategies and a control group consisting of (30) students who has studied with traditional method, the result found that the effectiveness of the study using the two strategies applied in the experimental at the achievement test. Also, the study revealed that there were no statistically significant differences between the two strategies applied.

Also, Abu-Atta's (2013) study aimed at knowing the effect of employing the learning cycle model in the development of creative thinking skills in Mathematics at ninth-grade students in Gaza, Palestine. The study implemented a pilot study on a sample of 28 students studied using the learning cycle strategy and another control group composed of 26 students taught using the traditional method, The results of the study showed a significant difference between the two groups in favour of the experimental group.

This positive increase in the experimental group's creative thinking skills in mathematics could result from employing the learning cycle model.

Mohammed (2016) investigated the impact of using 5Es instructional model on the achievement of mathematics and retention of learning among fifth-grade students. The researcher used the semi-experimental method comprising 30 students in the experiment group and 29 students in the control group, pre and post tests were used to see the difference between the two groups. The experimental group was taught using the constructivist approach by using the 5Es instructional model, while the control group was taught using the traditional method, A T-test was used to check the significant difference between the experimental group and the control group after the experiment.

It was explored that both the groups were equal regarding their achievement scores in the pre-test, but in post-test both were different in their achievement test scores in favour of experimental group. It was concluded that this significant performance of the experimental group may be due to teaching them with the 5Es instructional model.

In a similar research, Tezer and Cumhur (2017), conducted a research aimed at investigating the effect of education on the mathematics achievement, problem solving skills and the view of students on the 5E instructional model and the mathematical modelling method for the geometric objects unit. The students were randomly selected from the 8^{th} grade of secondary school in northern Cyprus. One group was the experimental group to which the 5Es instructional model was applied, and mathematical modelling was applied to the other group. Geometric objects multiple-choice achievement test was used as a data collection tool. Results of statistical analysis showed that the teaching provided by the 5Es instructional model in experimental group 1 and the mathematical modelling method in the experimental group increased the academic achievement of the students. However, the mathematics modeling method was more successful in the students' mathematical achievement and problem solving skills. The increased academic achievement of the student taught using the 5Es instructional model could be due to using the 5Es instructional model.

Madu and Ezeamugu (2013) conducted a research aimed at investigating the efficacy of 5Es at primary and secondary school levels. 134 primary four pupils participated, 72 were taught the concept of fractions in year four mathematics using the 5Es instructional model, while 62 were taught using the conventional method. The experimental group taught using 5Es instructional model has greater gains on the fraction achievement test than the comparism group taught using the conventional method. The greater gains in the fraction achievement test by the experimental group

could be attributed to the use of 5Es instructional model. Toraman and Demir (2016) conducted a research to bring together and contrast independent studies conducted on the effect of the constructivist approach on students' attitude to lessons and to analyse their results. A meta-analysis was employed in this research. The findings of this study demonstrated that students in the experimental group, in which studies were conducted according to the constructivist approach, displayed many more positive attitudes towards lessons than those in the control group who were taught according to more traditional learning methods. This outcome can be attributed to the use of the constructivist approach.

Alebiosu *et al.* (2017) investigated the impact of 5E and PDROD learning models on students' anxiety towards senior secondary chemistry using quasi-experimental pre-test-posttest-control group design. The treatments were at two levels: the learning cycle model (PDEODE and 5E) and the conventional lecture method, which was the control group. The moderating variables were gender (Male and Female) and cognitive style (field dependent and field independent). A total number of hundred and eighty-eight students (188) obtained from intact classes of three selected senior secondary schools in south-west Nigeria participated in the study. The Chemistry Anxiety Rating Scale (CAPLS) and Group Embedded Figure Test (GEFT) were the main instruments used to collect data from students.

Descriptive statistics and analysis of covariance (ANCOVA) were used to analyze the data collected. Also, Multiple Classification Analysis (MCA) was used to determine the magnitude of the mean anxiety scores of students exposed to the different treatment conditions. The results of the study revealed that there was a significant difference ($F_{(2,175)}$= 13.659, P <.05) in the post-test mean chemistry anxiety scores for different instructional strategies. The students' post-test mean chemistry anxiety scores after

exposure to the different instructional strategies varied significantly ($F_{(2,175)}$= 13.659, P <.05), between the sampled field-dependent and field-independent secondary school students. However, no significant main effect of gender and cognitive style on students' chemistry anxiety was found. The study concluded that exposing students to the PDEODE learning model reduced anxiety in chemistry compared to the 5E learning model and the conventional method.

Abu Atta (2013) conducted research on the effect of employing the learning cycle model in the development of creative thinking skills in mathematics at ninth-grade students in Gaza, Palestine. The study implemented a pilot study on a sample of 28 students studied using the learning cycle model and another control group composed of 26 students taught using the traditional method, The results of the study showed a significant difference between the two groups in favour of the experimental group. The experimental group's better achievement could be due to the use of the learning cycle model. Hamdani (2013) work aimed to study the effect of using the Bybee model in the achievement of fifty-grade students in mathematics and the development of formal thinking in Mosul city, Iraq. The study sample consisted of two groups; experimental thought by the Bybee model and control thought using the traditional method. Results indicated the effectiveness of using Bybee model in the achievement test compared to those who studied in the traditional method. The greater achievement of the experimental group resulted from employing the Bybee model.

Mohammed (2016) conducted an exploration of the impact of the 5E instructional model on fifth-grade students' maths achievement and retention of learning. The researchers randomly chose students at Khaouiss Mushayi province, Saudi Arabia, to participate in either experimental or control groups. The experimental group received treatment with 5E constructivist model, while the control group was taught using the

traditional method. He reported significant differences in achievement between the control group and the experimental group. He concluded that the 5E constructivist model affected the experimental group's learning.

Omotayo and Adeleke (2017) conducted a quasi-experimental research to examine differences between the control group's mathematics achievement and the treatment group taught using the 5E model. The study sample was composed of 155 senior secondary school students in the Ibadan metropolis, Oyo state of Nigeria. They found a significant effect of treatment on student's achievement in mathematics. Tuna and Kacar (2013) conducted a research work in a high school in Turkey in which the effect of 5E model on high school students' mathematics achievement and retention of their knowledge was examined, the treatment group was taught in an environment in which the 5E learning model approach was used, the control group was taught using the traditional method. The two groups were exposed to pretest with similar result; however the posttest results of the two groups were significantly different. They concluded that the student-taught trigonometry concept using the 5E model has a better learning outcome. It can be inferred here that the better learning outcome resulted from the 5E learning model.

Awofal *et al* (2013) researched to find out the impact of framing and team-assisted individualized (TAI) instructional methods on student's attitudes. The result revealed a significant main effect of treatment and gender on attitude mean score of subjects exposed to Tai and framing methods. It was concluded that Tai and framing strategies were more effective in promoting students' attitudes toward mathematics. This indicates that the use of teaching methods could change student's attitudes towards mathematics.

In a similar study, Aondoheinba and Iji (2020) investigated the effect of 5Es constructivist instructional approach on secondary school students' achievement and retention in chemistry in Benue State, Nigeria. Two research questions and two hypotheses guided the study. Quasi-experimental design was used for the study. A sample of 259 senior secondary two students from six secondary schools were selected using purposive and random sampling techniques. Chemistry Achievement Test (CAT) and Chemistry Retention Test (CRT) were the instruments used for data collection. The data collected were analyzed using mean and standard deviation to answer research questions, while analysis of covariance (ANCOVA) was used in testing the hypothesis at 0.05 level of significance. The result revealed that there was a significant difference between the mean achievement test scores of students taught chemistry using the 5Es constructivist instructional strategy and those taught using lecture method in favour of those taught chemistry using 5Es constructivist instructional strategy. It was concluded in this study that the use of E5s, a constructivist instructional strategy, enhances students' achievement in chemistry. This is similar to the present study, which concluded that 5Es instructional strategy enhances student achievement in Nigeria.

Similarly, Ematum (2018) investigated the impact of 5Es learning model on Academic performance in the chemical equation concepts among secondary school students, Katsina metropolis, Nigeria.

It employed a quasi-experimental pretest and posttest control group research design, featuring two groups (Experimental and control group). The study sampled eighty-one (81) SS 2 chemistry students from two secondary schools in the Katsina metropolis drawn from a population of 753 students. Balancing chemical equation performance test (BCEPT) with a reliability of 0.79 was used as an instrument for data collection. T-test statistic was used for data analysis. The result showed that students in the experimental

group performed significantly better than those in the control group. This present study is in line with the result, which indicated that students taught using 5Es Algeria instructional model performed significantly better than those taught using lecture method.

Binta et al. (2021) investigated the effect of the 5Es teaching cycle on retention ability in model concept among secondary school students of varied ability in Zaria Education Zone, Kaduna State. It employed a quasi-experimental pretest and posttest control group research design, consisting of two groups (Experimental and control group). The experimental group was taught using 5Es teaching cycle, while the control group was taught using the conventional lecture method. The study sampled eighty-one (81) SS 2 chemistry students from two secondary schools in Zaria education Zone drawn from a population of 1,154 students. The instrument for data collection was the Model Concept Retention Test (MCRT). Analysis of covariance (ANCOVA) was used for data analysis. The result revealed a positive effect in favour of the experimental group, it was concluded that 5Es can improve students' performance irrespective of ability level. This is similar to the findings of Gokhan (2016) Examined the effect of learning cycle approach-based teaching on academic achievement, attitude, motivation and retention at Primary school, 4^{th} grade science lessons. A sample of 65 students were used from two classes in a state school in the province of Kastamonu in Turkey. The study employed a quasi-experimental design. One way ANOVA and independent t-test was used to compare the groups' scores. The results revealed a significant difference in achievement, motivation and retention in favour of the experimental group; however, it indicated no significant difference in attitude between experimental group and control group. This significant difference in attitude between the two groups contrasts with

present research work that indicated a significant difference in attitude in favour of the experimental group taught algebra using 5Es learning cycle.

In their own efforts, Ajaja and Urhievwejire (2012) determined the effect of learning circle as an instructional strategy on biology and chemistry students' achievement. The design of the study was 2x2x3x6 pretest posttest non-equivalent control group quasi-experimental design. The samples of the study included six secondary schools, 112 science students and 12 biology and chemistry teachers. The instruments used for the study were teacher's questionnaire on knowledge and use of learning cycle (KULC); the Biology and Chemistry Achievement Test (BCAT). Data collected were analyzed with simple percentages, Analysis statistics. The Result revealed that learning cycle as an instructional method had a significant effect on students' achievement in biology and chemistry. This is in line with the present research, which revealed that the 5Es learning cycle is more effective in improving students' achievement than the lecture method on algebra.

In a similar effort, Yemi and Suryabayu (2017) researched whether teaching model learning cycles 5E is better than conventional teaching in teaching mathematics. Quasi-experiment by randomized control test group only design. It involves x years class students as population, x 7's class as experiment class used teaching model learning cycles 5E and x 85 class as control class used conventional teaching. Results showed that used teaching model learning cycle 5E is better than the class which did not use the model. This is in support of this present research, whose result showed that students taught algebra using 5Es instructional model performed better in the posttest than those taught using the conventional lecture method.

Khaled (2016) Conducted an investigation aimed at testing the effectiveness of teaching mathematics by using the 7Es learning cycle strategy in immediate and delayed achievement and retention among preparatory year students at King Saudi University (KSU), Saudi Arabia. The study sample consists of 73 preparatory year students, 35 in the experimental group and 38 in the control group. ANCOVA results analysis of the students' scores on the mathematics achievement test indicated that the 7Es learning cycle is more effective than the traditional method. This is in line with the present study's result, which revealed that 5Es instructional model is more effective than the traditional method.

Consequently, Shuaibu *et al.* (2021) conducted a study aimed at investigating the effect of 7E instructional strategy on the achievement and retention of SS II (11^{th} grade) Biology students in public secondary schools in Nigeria. Intact classes of 60 students were randomly selected and denoted as the experimental group taught with 7E and the control group taught using the traditional teacher-centred method. The result of the independent sample t-test for the post-test scores indicated a significant value of PL 0.05 for the achievement variable. The implication is that the adoption of 7E instructional strategy enhances students' achievement in biology.

Julius and Leomarich (2021) conducted a research, the study was to examine the effect of 5E Guided inquiry model on the achievement of grade 7 students in algebraic expressions. Two intact classes composed of twenty four (24) students each were used as sample, assigned to groups based on their first grading grade in mathematics7.A quasi-experimental approach was employed using a one-shot design with pretest posttest instruments used to collect data. Results showed that both student participants under control and experimental groups have a positive attitude towards mathematics. However, the experimental group had a significantly higher achievement than the

control group. The insignificant attitude between the experimental and control groups is in contrast to this present study which revealed that students taught algebra had a higher attitude score than those in the control group. And it is in agreement with the result of the present study in terms of achievements, which indicated that students taught algebra significantly performed higher than those in the control group.

Mata *et al.* (2012) investigated how certain diverse but interconnected variables like background motivation and social support can lead to clarification of learner attitudes towards mathematics and understanding of the defining factors of these attitudes in the school environment. The finding indicated positive attitudes towards mathematics and also stressed the main effects of grade and mathematics achievement on the attitudes. This shows that when appropriate methods and variables are employed, it can promote a positive attitude towards mathematics. The effectiveness of 5Es Model is therefore inconclusive.

2.3.2 Reflective discussion instructional strategy effectiveness

Studies evaluating the effectiveness of reflective group discussions and students' achievement and other variables toward reflective discussions are very few. Annetta (2011) suggested that semi-structured reflective group discussion enhanced students' enjoyment and perceived learning, and reflecting with others results in multiple-perspective learning if there is mindful of the process.

Gbemisola (2015) investigated the effectiveness of reflective reciprocal teaching techniques on student teachers' academic achievement and attitude in economics four null hypotheses were formulated to guide the study. The study adopted the quantitative method of inquiry, using specifically a pre-test, post-test, and quasi-experimental design. Three colleges of education out of 22 Federal Colleges of Education in Nigeria

were purposively selected based on certain criteria to be the sites for the study. The sample for the study consisted of 178 second year economics student teachers. The participants in the experimental group were exposed to six weeks of teaching using the reflective-reciprocal teaching strategy, while in the control group, they were exposed to the traditional method of teaching. The quantitative data collected was analyzed using descriptive statistics. The Multiple Classification Analysis (MCA) aspect of ANCOVA was used to determine the magnitude of the performance of the groups. The findings of the study showed that there exists a significant difference in the achievement of student-teachers in economics when taught using reflective reciprocal teaching strategies compared to the conventional method. Conversation is a beneficial method of reflective practice, especially when reflective conversations occur with a mentor or reflective supervisor and as exchanges between peers or communities of practice. Paula (2009) reported that teacher education have augend that reflection practice is characteristically associated with teacher autonomy empowerment and effective teaching. This study tries to devise strategy that supports student teachers' reflective practice.

Rupnow and Barker (2021), reported an outcome of a research work aimed at investigating the learning of one secondary school mathematics teacher through observation during class period. Results analyzed show that reflection in action was instrumental in relation to the community practice framework. The researcher proposed that the use of a cycle of reflection in action in professional communities may have a positive impact on teacher learning.

Gbamisola (2015) investigated the effectiveness of reflective reciprocal teaching techniques on student teachers' academic achievement and attitude in economics, four null hypotheses were formulated to guide the study. The findings of the study showed that there exists a significant difference in the achievement of student-teacher in

economics when taught using reflective reciprocal teaching strategies compared to the conventional method. The greater achievement by the experimental group could be as a result of the use of reflective action.

Lia *et al*. (2014), which indicated that the achievement of mathematics intuitive-reflective thinking ability students who worked under problem-Based learning achieved significantly higher than students who worked under conventional learning.

It has been observed in this study that reflection during learning has a tremendous effect on secondary school students' achievement, Iksan and Rahim (2017) conducted a study aimed at exploring the ways in which excellent teachers reflect as well as their reflection level by working at a video of teachers teaching at a school Nigeria Sembilan. The study was conducted with qualitative methods with 17 participants of excellent teachers, including two lecturers. Data was obtained using reflective observations, documents of the participants and recordings of the video critique sessions. Data was analyzed using reflective dialogue session video documents analytical technique that has been transcribed. It was found that there are four stages of reflection: Descriptive, Dialogue reflective, Descriptive Reflective and critical reflective. A majority of the excellent teachers reflected at the stage of dialogue reflected at the stage of dialogue reflective. This study implies a need for exposure to reflective practice during the process of observation so that teachers receive deep and meaningful feedback through practice in community learning. This is similar to the present study, as it enables students to dialogue in the process of reflective discussion.

Mevlut and Ahmet (2022) conducted research to investigate the effect of reflective thinking based teaching on academic achievement, retention and attitude towards English courses in secondary school English classes. The study adopted pretest –a

posttest design with experimental control groups in a private school in Konya for 8 weeks, 35 students in the 15th grade, 18 in the experimental and 17 in the control group was used as sampled students. The data obtained were analyzed using analytical of variance (ANOVA) to test the hypothesis. The result indicated that there is a significant difference in academic achievement and retention in favour of the experimental group taught English course using reflective thinking based teaching, The result further revealed that there is no significant difference in attitude toward English course of secondary school students taught using reflective thinking based teaching and those taught using conventional lecture method. This significant difference in attitude is not in line with the present research finding, which showed a significant difference in attitude towards algebra between students taught using reflective discussion and those taught using the conventional lecture method. However, it is in agreement with the result indicating a significant difference in the achievement of students in favour of the experimental group.

Ogbuanya and Owodunnic (2015) determined the effect of reflective inquiry instructional technique on the achievement of students in Technical Colleges. The study employed a pretest, posttest, non-equivalent control group, and quasi-experimental research design, using groups of students in intact classes assigned to experimental control groups. 105 students of Technical II were used as samples, and the electronic works achievement test (EWAT) was the instrument used for data collection. Analysis of variance (ANOVA) was used to test the hypothesis. The result revealed that reflective inquiry instructional techniques were more effective in improving achievement in electronic work trade regardless of ability levels. The present study showed that there is no significant difference in algebra achievement among ability levels taught using reflective discussion.

2.4 Summary of Literature Review

The literature reviewed was focused on three broad headings: conceptual framework, theoretical framework and empirical studies. An evaluation of the literature on Mathematics education suggests that Mathematics as a school subject, together with the way it is taught and learnt, appears very much inadequately researched in many parts of the world. Therefore research such as this current study, the effects of 5Es model and reflective discussion instructional strategy can be examined. This research will therefore, contribute to the existing body of knowledge on the effects of 5Es model and reflective discussion instruction strategy in the teaching of Mathematics.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The study employed quasi-experimental design, particularly the pretest-posttest non-equivalent control group design involving two experimental groups and one control group. This involved the employment of non-randomized groups, where the researcher could not randomly assign subjects to the groups, but intact classes were used. The use of intact classes enabled the study not to disrupt the school setting. The independent variables were the teaching methods, namely 5Es instructional model, reflective discussion instructional strategy and lecture method. The dependent variables were the algebra achievement test and attitude towards algebra inventory, while the moderating variable was ability level at three levels (high achievers, medium achievers and low achievers). The experimental group one was exposed to 5Es instructional model treatment, while experimental group two were exposed to reflective discussion instructional strategy as treatment. The control group was taught using the lecture method; the design is shown in Table 3.1.

Table 3.1 Research Design Layout

GROUPS	PRETEST	TREATMENT	POSTTEST
Exp 1	O_1	X_1	O_2
Exp 2	O_1	X_2	O_2
Control	O_1	X_O	O_2

Source: Researcher, 2023

Where O_1 – Pretest for experimental and control groups

O_2 - Posttest for experimental and control groups

X_2– Treatment for experimental group two

X_O – No treatment for control group

3.2 Population of the Study

The population for this study comprised of all the senior secondary school Two (SSII) students in Niger State. The population of Senior Secondary School Two (SSII) students in Niger State is fifty-three thousand, three hundred and fifty-eight (53,358) for 2018/2019 session. The data was obtained from the secondary education board statistics division. Public secondary school level is used because the population characteristics are the same, such as they are taught under the same environmental conditions, using the same curriculum containing the same algebraic concepts to be taught. The teachers are employed by the same employer and paid rumination from the same source. Senior Secondary School year Two (SSII) were suitable as the concepts that were taught are in the SS II syllabus. The nine schools are shown in Figure 3.1

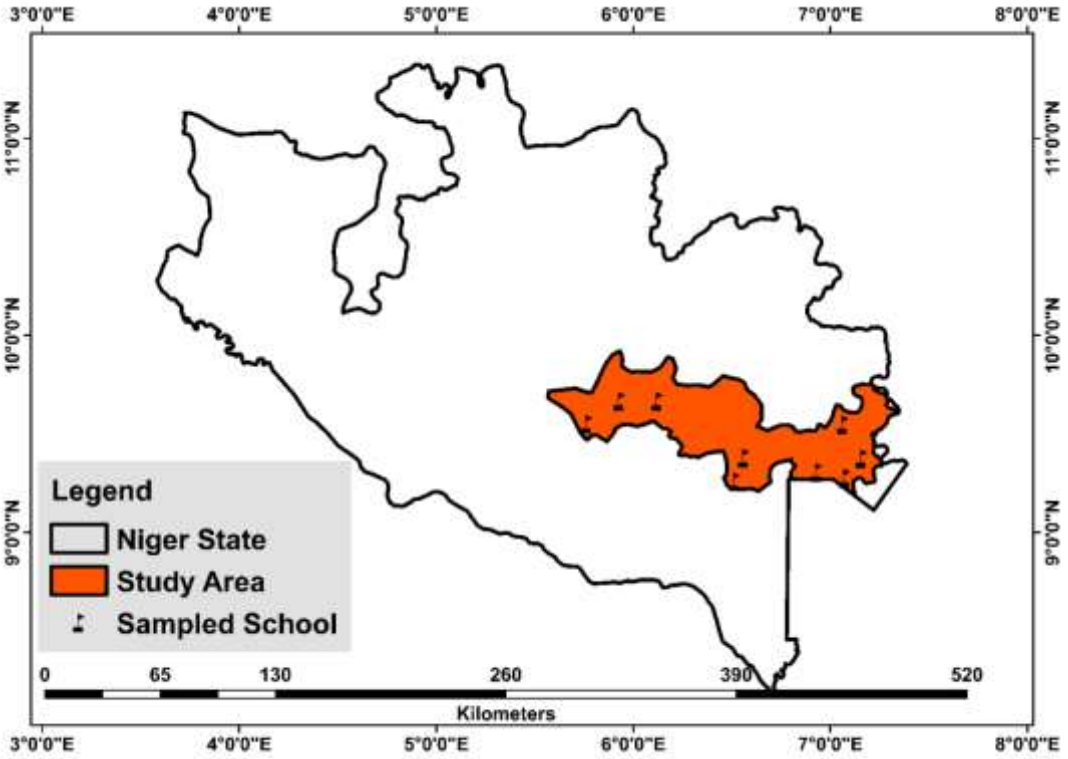

Figure 3.1: Map of Niger State showing the nine sampled schools.

3.3 Sample and Sampling Techniques

The sample for this study consisted of three hundred and forty-nine (349) students from nine (9) intact classes in nine (9) randomly selected secondary schools in Niger State. A multi-staged sampling technique was used to obtain the sample for the study. The multi-staged sampling was done in four stages: education zones, local government level, school level and class level. Niger state comprised of seven (7) educational zones, these are Minna office, Bida office, New-Bussa office, Kontagora office, Rijau office, Kutigi office and Suleja office. A simple random sampling technique using the hat draw method was employed to select three educational zones from the seven (7) zones at stage one; these are Bida office, Minna Office and Suleja office. Each educational zone comprised of Local Government areas, at stage two, a simple random sampling technique was employed to select one local government area in each of the randomly

selected educational zones; these are the Gurara Local Government area, Gbako Local Government area and Bosso Local Government area. At stage three, a simple random sampling technique was adopted to select three secondary schools from each of the selected local government areas, given a total of (9) secondary schools, In each of the schools selected, one intact class was randomly selected as research subject this gave the total sample classes of nine (9), the schools were labeled School A, School B, School C, School D, School E, School F, School G, School H, and School I.

Three classes were randomly assigned to experimental group one; three classes were randomly assigned to experimental group 2 and three classes were randomly assigned to the control group. The subjects in each of the randomly selected intact classes were identified and placed as high achievers, medium achievers and low achievers using their three consecutive previous mathematics scores obtained from the examination records in their respective schools. The distribution of the sample by schools and ability levels is shown in Table 3.2.

Table 3.2: Distribution of sample by school and ability levels.

School	Group	High Achievers	Medium A	Low A	Total
A	Exp I	08	25	18	51
B	Exp II	11	29	19	59
C	Contr	7	18	8	33
D	Exp I	08	18	12	38
E	Exp II	10	14	13	37
F	Contr	6	14	13	33
G	Exp I	05	10	13	28
H	Exp II	08	15	18	41
I	Contr	5	17	7	29
	Total	68	160	121	349

In Table 3.2, schools A, D and G formed the experimental group one (Exp. I), schools B, E and H formed experimental group two (Exp II) and schools C, F and I formed the control group (Crl).

3.4 Research Instruments

The research instruments were categorized into two: response instruments and stimulus instruments. The response instruments are the Algeria Achievement Test (AAT) and the Attitude TowardsAlgebra Inventory (ATAI). While stimulus instruments are treatment instruments, which include; a lesson guide using 5Es instructional model, a lesson guide using reflective discussion instructional strategy and a lesson guide using lecture method.

3.4.1 Algebra achievement test (AAT)

The researcher prepared the questions in ways that reflect the Nigerian algebra curricular prescriptions. The study was designed to teach algebraic concepts at secondary school year two. The test consisted of thirty (30) multiple choice items with five options (A-E); the aspect of the algebra concept focused was quadratic equation. The maximum score for the instrument (AAT) is one hundred percent (100%); each appropriately answered question attracted a score of one mark, which was transformed to a percentage to arrive at the total scores of each participant. Preparation of the test items was guided by table of specifications, this is shown in Table 3.3.

Table 3.3: Table of Specification for Algebra Achievement test

		Level of difficulty			
Majorarea	**Specific Content**	**Number of items**	**Low**	**Moderate**	**High**
Quadratic equation	Factorization of perfect squares	9	2,4	3,5,6,12,26	27,15
	Making quadratic expression perfect squares by adding a constant K	8	10	7,11,13,14,29	8,9
	Solution of quadratic equation by the method of completing the square	5		16,19,20,21	1
	Deducing the quadratic formular from completing the square	3	17	28	3,8
	Construction of quadratic equation from sum and product of roots	4	23	30,22	24
	Word problems leading to quadratic equation	1			25
	Total	**30(100%)**	**5(16.6%)**	**17(56.7%)**	**8(26.7%)**

Table 3.3.Shows the difficulty level of test items in percentages. As shown in the table, 5 items represented 16.6% of the total items. Categorized under low level of difficulty, 17 items, representing 56.7%, are under moderate difficulty level while 8 items, which 26.7%, are under high difficulty level.

3.4.2 Attitude towards algebra inventory (ATAI)

Attitude Towards Algebra Inventory (ATAI) is an Algebra Attitude Questionnaire for obtaining learners' attitudes towards algebra. The questionnaire was divided into two sections. Section A consisted of the respondent's demographic information, while section B consisted of twenty (20)questionnaire items on students' attitudes towards algebra. The students were asked to answer the options that match their view in the following ways: Strongly Agreed (SA), Agreed (A), Disagreed (D), and Strongly

Disagreed (SD) (See Appendix A, PP 98). The items were scored on the basis of the weight of each point: 4,3,2,1 for positive items SA, A, D, SD and 1,2,3,4 for negative items respectively. The instrument was used as a pretest and posttest to determine the effect of change in attitude of the students before and after exposure to the treatments.

3.4.3 Treatment instruments

These were lesson guides containing contents of concepts taught. They were prepared according to the steps and guidelines involved in each of the 5Es and reflective dissuasion methods and for control using the lecture method. The contents/concepts taught in algebra were the same, but the procedure or method used for each group depend on the instructional strategy.

5Es model lesson guide involved five stages: engage, explore, explain, elaborate and evaluate. At the engagement stage, the teacher generates interest and determines students' prior knowledge. Students were invited to pose their own questions. At the exploration stage, students were encouraged on student-to-student interaction and provided time for students to puzzle through problems. At the explanation stage, students were asked questions that helped them express understanding and explanations, the teacher explained or clear misconceptions. Elaboration stage focused on students' attention on conceptual connections between new and former experiences. Finally, at the evaluation stage, students observed and recorded as students demonstrated their understanding of the concepts and performance of skills. Table 3.4 shows 5Es stages and model of instruction.

Table 3.4: 5Es stages and modes of instruction

5ES STAGES	TEACHER-DIRECTED	TEACHER-ASSISTED	PEER-ASSISTED
Engagement	●		
Explore			●
Explain		●	●
Elaborate		●	●
Evaluate	●	●	●

Source: BSCS (2011)

Reflective discussion instructional strategy involves four (4) stages: Planning, prediction, Clarifying and summarizing. At the planning stage, students are grouped into small heterogeneous groups encouraged to adopt a cooperative style of learning. Here, the teacher provides instruction and also engages the learners by providing them with the content text for individual study. At the prediction stage, the teacher encouraged learners and solved problems collaboratively, and at the clarification stage, the teacher as a moderator cleared misunderstandings and misconceptions. Finally, at the summarizing stage, the teacher together with the learner, solves more problems and facilitates discussion amongst students, giving more work to the learner for further practice, which has connection with what has been learnt and the future concept to be learned.

In the control group, the class lesson involved an introduction presentation of the lesson, students' activities and an evaluation of the lesson (students).

3.5 Validity of Research Instruments

All the instruments were subjected to validation; the researcher gave them to experts in mathematics, mathematics educators and psychologists. According to Hassan (2012),

validity implies the degree or extent to which a research instrument measures what it is purported to measure. To ensure uniformity in learning, the researcher visited the nine selected secondary schools, and students were taught the same content of the secondary school algebra as it contained in the secondary school curriculum. The constructed test items were cross-checked by the researcher's major supervisor. It was then validated by mathematics experts, mathematics teachers from sampled secondary schools at the rank of Assistant Director Education (ADE) and Chief Education Officer (CEO). They were provided with a guide containing:

i. The title of the study objective of the study, research questions and hypotheses (see Appendix A, PP 98), the AAT and ATAI instruments and AAT answers (see Appendix B, PP 100).
ii. Content of algebra as in the secondary school curriculum.
iii. Validation form for AAT and ATAI

The researcher solicited for their views on

a. Appropriateness of the instrument for the purpose it was designed for.
b. Clarity and simplicity of the language used
c. Suitability for the level of the targeted audience
d. The extent to which the item covered the topic it meant to cover
e. The structuring of the questionnaire
f. General overview of the instrument and
g. Suggestions for improving the instrument.

3.5.1 Validity of AAT and ATAT

All the thirty (30) items in the AAT were rated appropriate, adequate and suitable by the validators, and modification were made to items which were more appropriate. On ATAI, all 20 items were rated appropriate. All recommendations were strictly adhered to.

3.5.2 Validity of Lesson Plan

The validators recommended the suitability and appropriateness of lesson plans for both the experimental groups and the control group; observations and suggestions were made, which were all adhered to (see Appendix J, PP 158-64).

3.6 Reliability of the Research Instruments

The Algebra Achievement test (AAT) and Attitude Towards Algebra Inventory were pilot-tested to determine their reliability.

Reliability is the degree to which a measuring instrument (test, questionnaire) produces the same results on repeated applications. It is the extent of an instrument producing the same results consistently. It is the steadiness of measures or internal consistency of measurement instruments. Reliability in statistics and psychometrics is the overall consistency of a measure; a measure is said to have a high reliability if it produces similar results under consistent conditions. There are a lot of statistical tools that can be employed in measuring the extent of internal consistency of a test. The AAT was administered twice during the pilot testing, and the results obtained were coded and subjected to the Person Product-Moment Correlation (PPMC) test using SPSS version 16.0 and liability coefficient (α) of 0.937 was obtained. This indicated a high reliability, as shown in Table 3.4.

PPMC tests was suitable because the data obtained were in interval scale and test-retest method of testing reliability was adopted. According to Hassan (2019), Cronbach's alpha is one of the famous indexes described and stated in testing and evaluation item analysis. Cronbach's alpha ranges from 0 to 1.00, value close to 1.00 suggests high consistency, and a reliability of 0.7 and above is the most suitable. For standardized tests, high-reliability coefficients are essential since the test was administrated once and the result of the test was used in drawing conclusions about every learner (Hassan, 2019). In this study, to determine the reliability of ATAI, the test was administered once on secondary school students in SSII but outside the sample of the actual study. Cronbach's alpha was used to measure the reliability. Data from the pilot test was coded and key into SPSS spreadsheet, it was analyzed and alpha value of 0.853 was obtained for ATAI. The results is shown in Table 3.5.

Table 3.5: Reliability of the AAT and ATAI

Instruments	**PPMCC**	**Cronbach's Alpha**	**No. of items**
Algebra Achievement Test	0.94		30
Attitude Towards Algbra Inventory		0.8520	

In Table 3.4 above, the reliability of AAT and ATAI were calculated separately and gave $\alpha = 0.937$ and 0.853 respectively which were considered reliable.

3.7 Method of Data Collection

The researcher visited the sampled schools for this study and sought for official permission from the school authority, collected previous results of the sampled intact classes and determined their ability levels in the first week, and pretest was administered, treatment followed by given in each of the schools for Six weeks and posttest was be administered in one week. The researcher conducted the teaching in the

sampled schools and used the school teachers as research assistants for the administration of the test. This process is indicated in table 3.5

Table 3.6: Schedule of Data Collection

WEEK	ACTIVITY
Week One	Visitation to the schools to obtain official permission and to collect previous results to group the subjects into high, medium and low achievement.
Week Two	Training of research assistance and administrating of pretest.
Week three to week eight	Treatments were given for both experimental and control groups
Week nine	Post-test was administered and the collection of results.

3.8 Method of Data Analysis

The data obtained were analyzed using mean and standard deviation, which provided answers to the research questions. It was also subjected to analysis of variance (ANOVA), using a statistical package for social sciences (SPSS) to test the null hypotheses. Decisions to accept or reject the P-values computation were made at 0.05 level of significant. The pretest results were analyzed using ANOVA and the P-Value obtained was found to be insignificant. There was no significant difference among the groups at pretest. Therefore, ANOVA was adopted to test the six hypotheses using statistical package for Social Sciences (SPSS) software

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Pretest Results

The purpose of pretest was to establish the equivalence of the groups before giving the treatment. To analyze the pretest scores, the mean scores and standard deviation of the experimental group and control group on the Algebra Achievement Test (AAT) and Attitude Towards Algebra Inventory (ATAI) were computed and compared using one-way analysis of variance (ANOVA), Results are here presented.

Table 4.1: Pretest achievement of experimental and control groups.

		Pretest	
Groups	**N**	$\bar{X}$	**SD**
Exp I	117	26.45	5.55
Exp II	137	24.10	10.81
Ctrl	95	23.89	10.01
Total	349	26.33	8.38

The result in Table4.1 shows that experimental group one (those taught algebra using 5Es instructional model) had a mean and standard deviation scores of 26.45 and 5.55, respectively. In the pretest, experiential group two (those taught using reflective discussion instructional strategy) had mean and standard deviation scores of 24.10 and10.81 respectively. Similarly, the control group (those taught using traditional method) had mean and standard deviation scores of 23.89 and 10.01 respectively.

This is an indication that there is variation in the mean scores of the experimental and control groups. As a result of this observed difference in mean achievement scores at

pretest, the scores were tested at a 0.05 significant level to determine if the observed difference was significant. This is shown in Table 4.2.

Table 4.2: ANOVA Table for Testing the Significance Among Mean Achievement Scores for Experimental Groups and Control Groups in Pretest

	Sum of Square	**Df**	**Mean Square**	**f-value**	**Sig**
Between groups	287.667	2	143.833	2.062	0.129
Within groups	24139.564	346	69.768		
Total	24427.231	348			

Not significant

Table 4.2 reveals that F-value is 2.062 and the corresponding probability value (P-Value) is 0.129. The F-value is not significant at 0.05; this is because 0.129 is greater than 0.05 (P= 0.129; P>0.05). This implies that there is no significant difference in mean achievement scores of students taught algebra using 5Es instructional model, reflective discussion instructional strategy and traditional method in pretest. This revealed that students in the experimental groups and control had similar backgrounds in achievement on concepts of algebra taught before the treatment was administered.

Table 4.3: Mean attitude and standard deviation scores for the experimental and control groups in pretest.

		Pretest	
Groups	**N**	$\bar{X}$	**SD**
Exp I	117	24.03	9.61
Exp II	137	23.44	8.33
Ctrl	95	26.46	5.38
Total	349	24.11	8.17

The result in Table 4.2 shows that experimental group one had a mean and standard deviation scores of 24.03 and 9.61, respectively. Experimental group two had a mean

and standard deviation scores of 23.44 and 8.33, respectively. Similarly, the control group had mean and standard deviation scores of 26.46 and 5.38 respectively. It indicated that those in control group had a higher mean score of 26.46, those in experimental group one had a mean attitude score of 23.91, while those in experimental group two had a mean attitude score of 23.44 hence variation is observed among the three mean attitude scores ANOVA analysis was employed to determine if the observed difference was significant. This is shown in Table 4.4

Table 4.4: ANOVA TableFor Testing The Significance Among Mean Attitude Scores For Experimental Groups and Control Group in Pretest

	Sum of Square	**Df**	**Mean Square**	**f-value**	**Sig**
Between groups	148.453	2	7325.341	0.477	0.621
Within groups	22994.853	346	15358.876		
Total	23143.306	348			

Not significant

Table 4.4 reveals that F-value of 0.477 and the corresponding probability value (P-Value) is 0.621. The F-value is not significant at 0.05; this is because 0.621 is greater than 0.05 (P= 0.621; P>0.05). This shows that there is no significant difference in mean attitude scores of students taught algebra using 5Es instructional model, reflective discussion instructional strategy and traditional method in pretest. This indicated that students in the experimental groups and control had similar backgrounds in attitudes towards concepts of algebra taught before the treatment was administered.

Table 4.5: Mean and Standard Deviation on Pretest Achievement Among Secondary School Students of Different Ability Levels Taught Algebra using 5Es Instructional Model.

		Pretest	
Groups	**N**	$\bar{X}$	**SD**
High Ability	21	27.06	8.75
Medium Ability	53	24.66	10.90
Low Ability	43	24.55	11.40

The result in Table 4.5 indicated that the high ability group had a mean and standard deviation of 27.06 and 8.75, respectively, and the medium ability group had a mean and standard deviation of 24.55 and 11.40, respectively. An observation of the Table shows variation among the scores. ANOVA analysis was employed to determine if the observed difference was significant. This is shown in Table 4.6 below.

Table 4.6: ANOVA Table For Pretest on Achievements Among Different Ability Groups in Experimental Group (Exp I)

	Sum of Square	**Df**	**Mean Square**	**f-value**	**Sig**
Between groups	103.944	2	51.972	.450	.639
Within groups	13170.138	114	115.528		
Total	13274.082	116			

Not significant

Table 4.6 Shows one-way analysis of variance (ANOVA) comparison of pretest achievement scores for students of different ability levels taught using 5Es, model of instruction from the Table f-value is 0.450 and P-Value is 0.639.

The F-Value = 0.450 not significant at 0.05 since 0.639 is greater than 0.05 (P= 0.639; P> 0.05. This implies that there is no significant difference in mean achievement scores

among students with different ability levels taught algebra using 5Es model of instruction in pretest.

Table 4:7: Pretest attitude scores among students of different abilities in experimental group two (Exp. II).

		Pretest	
Groups	**N**	**$\bar{X}$**	**SD**
High Ability	29	27.40	7.34
Medium Ability	58	24.45	5.75
Low Ability	50	25.82	7.71

The result in Table 4.7 Shows that high ability group had mean and standard deviation scores of 27.40 and 7.34, respectively. Medium ability group had mean and standard deviation scores of 24.45 and 5.75, respectively. Similarly, low low-ability group had a mean and standard deviation score of 25.82 and 7.71, respectively. The high ability group had a higher mean achievement score of 27.40, followed by the low-ability group that got a mean achievement score of 25.82 and the medium ability group had the least mean achievement score of 24.45. ANOVA analysis was employed to determine if the observed difference was significant.

Table 4.8: ANOVA Table for Pretest Attitude Scores Among Different Ability Groups in Experimental Groups Two (Exp. II)

	Sum of Square	**Df**	**Mean Square**	**f-value**	**Sig**
Between groups	172.149	2	86.074	1.827	0.165
Within groups	6267.135	134	47.121		
Total	6429.284	136			

Not significant

Table 4.8: Shows one-way analysis of variance (ANOVA) comparison of pretest attitude scores or students of different abilities taught algebra using reflective discussion

instructional strategies. In the Table, F-value = 1.827 and P-Value = 0.165, F-Calculated is not significant at 0.05 (P=0.165; P>0.05). This shows that there is no significant difference in the mean attitude scores among students of different abilities taught algebra using reflective discussion instructional strategy at pretest. This implies that the students were on the same level of performance before treatment was given.

4.1.1 Posttest Results

Research Question One

What is the mean difference in algebra achievement scores among secondary school students taught using 5Es model, those taught using the reflective discussion instructional strategy and those taught using the lecture method? The result is presented in Table 1

Table 4.9: Mean achievement and standard deviation scores for the experimental groups and control group in pretest and post test.

Group		Pretest		Posttest		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	SD	
Exp. I	117	26.45	5.55	57.73	9.53	31.28
Exp. II	137	24.10	10.81	58.19	9.88	34.09
Ctrl.	95	23.89	10.01	44.34	9.44	20.45

The result in Table 4.9. indicates that experimental group one had a Mean achievement score of 26.45 and standard deviation of 5.55 in the pretest, experimental group two had a mean achievement score of 24.10 and standard deviation of 10.81 in the pretest. In contrast, the control group had a mean and standard deviation scores of 23.89 and 10.01 respectively in pretest achievement scores. Similarly, in posttest scores, experimental group one had mean and standard deviation scores of 57.73 and 9.53, respectively. The

experimental group two obtained mean and standard deviation achievement scores of 58.19 and 9.88, respectively, and the control group obtained a mean and standard deviation scores of 44.34 and 9.44, respectively, in posttest.

The results further indicated that the mean achievement of students who were taught algebra using 5Es instructional model was 26.45 and 57.73 in pretest and posttest respectively, the mean achievement of those taught using reflective discussion instructional strategy was 24.10 for pretest and posttest of 58.19 while the mean achievement of students taught lecture method was 23.89 for pretest and 44.34 for posttest.

This revealed that those taught using 5Es instructional model obtained a higher mean score, followed by those taught using the reflective discussion strategy and those taught using lecture method had a lower mean score.

Research Question Two

What is the difference in mean attitude scores towards algebra among secondary school students taught using 5Es instructional model, those taught using the reflective discussion instructional strategy and those taught using lecture method? The result is presented in Table 4.10.

Table 4.10: Mean attitude Score and Standard Deviation For Experimental and Control Groups.

Group		**Pretest**		**Posttest**		**Mean Gain**
	N	$\bar{X}$	**SD**	$\bar{X}$	**SD**	
Exp. I	117	24.03	9.61	57.47	9.42	33.44
Exp. II	137	23.44	8.33	57.97	9.75	34.53
Ctrl.	95	26.46	5.38	44.77	9.43	18.31

In Table 4.10 Experimental group one had Mean attitude score of 24.03 and a standard deviation of 9.61 in pretest, experimental group two obtained mean attitude score of 23.44 and standard deviation of 8.33 in the same pretest, while the control group had mean attitude score of 26.46 and 5.38 standard deviation in pretest. In posttest, experimental group one had 57.47 for mean attitude score and standard deviation of 9.42, experimental group two obtained a mean attitude score and standard deviation of 57.97 and 9.75, respectively, while the control group had a mean attitude score of 44.77 and standard deviation of 9.43.

This is to say that experimental group one taught using 5Es model had mean attitude score of 24.03 in pretest and 57.47 in posttest. Those taught using reflective discussion strategy scored 23.44 and 57.97 in pretest and posttest, respectively; while the control group had mean attitude scores of 25.16 and 44.77 in pretest and posttest respectively. This shows that those taught using 5Es model had a higher mean attitude score than those taught using reflective discussion strategy and those taught using lecture method. However, the result indicated that those taught using reflective discussion method scored higher than the control group.

Research Question Three

What is the difference in mean achievement scores among secondary school students of different ability levels taught algebra using 5Es instructional model?

The result is presented in Table 4.3.

Table 4.11: Means and Standard Deviations of the Algebra Achievement Scores in Pretest and Posttest of the Experimental Group one (Exp. I) Based on Ability Groups.

Ability Group	Pretest		Posttest		Mean Gain
	N	X	SD	X	SD
High Ability	21	27.06	8.75	58.04	9.57	30.98
Medium Ability	53	24.66	10.90	57.81	9.74	33.15
Low Ability	43	24.55	11.40	57.39	9.54	32.84

Table 4.11 shows mean and standard deviation of the achievement score of high-ability group, medium-ability group and low-ability group taught algebra using 5Es instructional model. The result revealed the mean and standard deviation of pretest and posttest achievement scores of the high ability group to be 27.06 ± 8.75 and 58.04 ± 9.57, respectively. This gives a mean gain score of 30.98. The mean and standard deviation of pretest and posttest achievement scores of medium ability group is 24.66 ± 10.90 and 57.81 ± 9.94, respectively. This gives a mean gain score of 33.15. Similarly, the mean and standard deviation of pretest and posttest achievement scores of low low-ability group is 24.55 ± 11.40 and 57.39 ± 9.54, respectively. This gives a mean gain score of 32.84. However, the average main gain difference between the high-ability group, medium-ability group and low-ability group is 1.1 in favour of medium-ability group.

Research Question Four

What is the difference in mean attitude score among secondary school students of different ability levels taught algebra using 5Es instructional model?

The result is presented in Table 4.4.

Table 4.12: Mean And Standard Deviation Scores of The Attitude Scores of Experimental Group one Across Ability Levels.

Ability Group		Pretest		Posttest		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	SD	
High Ability	21	24.62	6.64	59.43	10.27	34.81
Medium Ability	53	24.10	10.81	58.25	9.25	34.15
Low Ability	43	24.29	10.80	56.21	9.09	31.92

Table 4.12 shows Mean and standard deviation of the attitude scores of high ability group, medium ability group and low ability group taught algebra using 5Es instructional model. The result shows that mean and standard deviation of pretest and posttest attitude scores of the high ability group is 24.62 ± 6.64 and 59.43 ± 10.27, respectively. This gives a mean gain score of 34.81. The mean and standard deviation of pretest and posttest attitude scores of medium ability group is 24.0 ± 10.81 and 58.25 ± 9.25, respectively; this gives a mean gain score of 34.15. Similarly, the mean and standard deviation of pretest and posttest attitude scores of low ability group is 24.29 ± 10.80 and 56.21 ± 9.09, respectively; this gives a main gain score of 31.92. However, the average mean gain difference between the high ability group, medium ability and low ability group is 1.92 in favour of high ability group.

Research Question Five

What is the difference in the mean achievement scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy?

The result is presented in Table 4.5.

Table 4.13: Means and Standard Deviation of Algebra Achievement Scores in Pretest and Posttest of the Experimental Group Two (Exp. Ii) Across Ability Levels.

Ability Group		Pretest		Posttest		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	SD	
High Ability	29	23.75	7.51	55.58	8.45	31.83
Medium Ability	58	20.78	7.20	58.10	9.10	37.32
Low Ability	50	23.14	7.36	56.99	9.12	33.85

In Table 4.13: The mean and standard deviation of the achievement scores of high group, medium ability group and low ability group taught algebra using reflective discussion instructional strategy are presented. The result indicates that mean and standard deviation of pretest and posttest achievement scores of the high-ability group is 23.75 ± 7.51 and 55.58 ± 8.45, respectively; this gives a mean gain of 31.83. While the mean and standard deviation of pretest and posttest achievement scores of medium ability group is 20.78 ± 7.20 and 58.10 ± 9.10, respectively; this gives a mean gain of 37.32. Similarly, the mean and standard deviation of pretest and posttest achievement scores of low ability group is 23.14 ± 7.36 and 56.99 ± 9.12, respectively; this gives a mean gain of 33.85. However, the average mean gain difference between the high-ability group, medium-ability group and low-ability group is 3.51 in favour of medium-ability group.

Research Question Six

What is the difference in the mean attitude scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy? The result is presented in Table 4.6.

Table 4.14: Means and Standard Deviation of the Attitude Scores of Experimental Group Two (Exp. II) Across Ability Levels.

Ability Group		Pretest		Posttest		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	SD	
High Ability	29	27.40	7.34	58.49	9.44	31.09
Medium Ability	58	24.45	5.75	59.09	10.84	34.64
Low Ability	50	25.82	7.71	56.90	8.97	31.08

In Table 4.14: Shows the mean and standard deviation of the attitude scores of high ability group medium ability group and low ability group taught algebra using reflective discussion instruction instructional strategy. The result shows that mean and standard deviation of pretest and posttest attitude scores of the high ability group is 27.30 ± 7.34 and 58.49 ± 9.44 respectively, this gives a mean gain score of 34.81. The mean and standard deviation of pretest and posttest attitude scores of medium ability group is 24.45 ± 5.75 and 59.09 ± 10.84 respectively, this gives a mean gain score of 34.64. Similarly, he mean and standard deviation of pretest and posttest attitude scores of low ability group is 25.82 ± 7.71 and 56.90 ± 8.97 indicating a mean gain score of 31.08. However, the average mean gain difference between the high-ability and low-ability group is 2.37 in favour of medium-ability group.

4.2 Research Hypothesis

Null Hypothesis One (Ho_1):

There is no significant difference in the mean achievement scores among secondary school students taught algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method in Niger state.

Table 4.15: Analysis of Variance (ANOVA) comparison of the posttest mean achievement scores of the experimental groups and the control group

	Sum of Square	Df	Mean Square	F-Value	P-Value
Between groups	11759.247	2	5879.623	63.22	.0001
Within groups	32179.613	346	93.005		
Total	43938.860	348			

Significant

The result in Table 4.15 shows that F-Value is 63.22 with degree of freedom 348 at alpha Value 0.05 level of significance. The P-Value 0.0001 obtained is less than 0.05 level of significance. This result shows that at p= 0.0001<0.05 there is significant difference among the mean achievement scores of the two experimental groups and the control group. Therefore, hypothesis one, which states that there is no significant difference in the mean achievement scores among secondary school students taught algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method is thus rejected. A post-Hoc (Scheffe post-Hoc test) was performed to show the direction of the differences, the result is presented in Table 4.16.

Table 4.16: Post-hoc (Scheffe) analysis of the posttest mean achievement scores of experimental groups and control group

(I) trtm	(j) trtm	Mean Difference (I-j)	Std Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.46069	1.21399	.931	-3.4451	2.5238
	3	12.78548*	1.33188	.000	9.5112	16.9597
2	1	.46069	1.21399	.931	-2.5238	3.4451
	3	13.24617*	1.28758	.000	10.0808	16.4115
3	1	-12.78548*	1.33188	.000	-16.0597	9.5112
	2	-13.25*	1.28758	.000	-16.4115	-10.0808

Significant

Table 4.16 shows the post-Hoc analysis which indicates that the difference observed is between students in control groups and those in experimental one and experimental group two. No significant difference was observed in mean achievement of those in experimental group one and experimental group two.

EXP I Compared with EXP II had P-Value=0.931 greater than 0.05. This shows that there is no significant difference between EXP I and EXP II. EXP I compared with Control group has P-Value=0.000, indicating a significant difference between EXPI and Control group.

Similarly, Experimental group 2 compared with Experimental group 1 has P-Value=0.931, which indicates no significant difference between them with the mean difference of 13.2.

However, when EXP 2 was compared with Control 3 the P-Value -0.000, this shows a significant difference.

Control 1 group compared with Experimental group 1 has P-Value -0.000, indicating a Significant difference, when compared with Experimental group 2, the P-Value=0.000, which shows there is a Significant difference.

Null Hypothesis Two (Ho_2)

There is no significant difference in mean attitude scores towards algebra among secondary school students taught using 5Es instructional model, reflective discussion instructional strategy and lecture method.

Table 4.17: Analysis of Variance (ANOVA) comparison of the posttest mean attitude scores of experimental groups and control group

	Sum of Square	Df	Mean Square	F-Value	P-Value
Between groups	11638.968	2	5819.484	63.80	0.0001
Within groups	31558.660	346	91.210		
Total	43197.627	348			

Significant

Table 4.17 shows ANOVA Table for testing hypothesis two. The result revealed that F348 = 63.80 with P-Value = 0.0001, P<0.05 level of significant. This indicates that there is a significant difference in mean attitude scores among secondary school students taught algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method. Thus hypothesis two is therefore rejected, that is alternative hypothesis which states that there is a significant difference in the mean attitude scores among secondary school students taught algebra using 5Es instructional model, reflective discussion instructional strategy and lecture method was retained. A post-Hoc analysis was performed to show the direction of the differences. The result is presented in Table 4.18

Table 4.18: Scheffe Post-Hoc analysis of the posttest mean attitude scores of experimental groups and the control group.

(I) trtm	(j) trtm	Mean Difference (I-j)	Std Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.49383	1.20222	.919	-3.4493	2.4617
	3	12.69958*	1.31897	.000	9.4571	15.9421
2	1	0.49383	1.20222	.919	-2.4617	3.4493
	3	13.19341*	1.27510	.000	10.0587	16.3281
3	1	-12.69958*	1.31897	.000	-15.9421	-9.4571
	2	13.19*	1.27510	.000	-16.3281	10.0587

Significant

Table 4.18: Is the result of post-Hoc analysis which shows that the difference found is between control groups and those subjects in experimental group one and group two. However no significant difference was noticed in mean attitude scores of those in experimental one and experimental two.

EXP I Compared with EXP II had P-Value=0.919 greater than X –Value of 0.05. This shows that there is no significant difference between EXP I and EXP II. EXP I compared with the Control group has P-Value=0.000, indicating a significant difference between EXP I and the Control group.

Similarly, Experimental group 2 compared with Experimental group 1 has P-Value=0.919, which indicates no significant difference between them with the mean difference of 13.19.

However, when EXP 2 was compared with Control 3 the P-Value -0.000, shows a significant difference.

Control 1 group compared with Experimental group 1 has P-Value -0.000, indicating a Significant difference; when compared with Experimental group 2, the P-Value=0.000, which shows there is a Significant difference.

Null Hypothesis Three (Ho_3)

There is no significant difference in the mean achievement scores among secondary school students of different ability levels taught algebra using 5Es instructional model in Niger state

Table 4.19: ANOVA Table for testing the significance among mean achievement scores for students of different ability levels in experimental groups one.

	Sum of Square	Df	Mean Square	F-Value	P-Value
Between groups	7.193	2	3.596	0.039	0.962
Within groups	10584.926	114	92.850		
Total	10592.119	116			

Not Significant

Table 4.19 shows the ANOVA Table for testing the significance effect of treatment and ability levels on the mean achievement scores of students taught algebra using 5Es instructional model. The Table revealed that F-Calculated value of 0.039 and the corresponding P value of 0.962 is greater than 0.05, that is (P = 0.962>0.05) hence the hypothesis is not rejected, meaning that there is no significant difference in the mean achievement scores among secondary school students of different ability levels taught algebra using 5Es instructional model.

Null Hypothesis Four (Ho_4)

There is no significant difference in the mean attitude scores towards algebra among secondary school students of different ability levels taught using 5Es instructional model in Niger state

Table 4.20: ANOVA analysis of posttest mean attitude scores among secondary school students of different ability levels taught algebra using 5Es instructional model.

	Sum of Square	df	Mean Square	F-Value	P-Value
Between groups	174.183	2	87.091	.990	.375
Within groups	10028.030	114	87.965		
Total	10202.213	117			

Not Significant

To test hypothesis four, the result of posttest mean attitude scores of experimental group one was analyzed using ANOVA statistics. The result is presented in Table 4.18. In Table 4.24, the F-Value 0.990, resulting in P-Value = 0.375> 0.05, indicate that there was no significant difference in attitude towards algebra among secondary school students of different ability levels taught using 5Es model. Therefore, hypothesis four was retained. This is to say that 5Es instructional model is not biased in terms of attitude towards algebra among secondary school students of different ability levels.

Null Hypothesis Five (Ho_5)

There is no significant difference in the mean achievement scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy.

Table 4.21: ANOVA Table for testing the significant among mean achievement scores for students of different ability levels in experimental group two.

	Sum of Square	df	Mean Square	F-Value	P-Value
Between groups	125.68	2	62.840	.780	.460
Within groups	10789.214	134	80.517		
Total	10914.894	136			

Not Significant

Table 4.21: Showed that F136 = .780 with P-Value = .460, P>0.05 level of significant level. Therefore P-Value is not significant at 0.05 level. This indicates that there is no significant difference in the mean achievement scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy. Hypothesis five is, therefore, retained.

Null Hypothesis Six (Ho_6)

There is no significant difference in the mean attitude scores towards algebra among secondary school students of different ability levels taught using reflective discussion instructional strategy in Niger State.

Table 4.22: ANOVA test on posttest mean attitude scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy.

	Sum of Square	Df	Mean Square	F-Value	P-Value
Between groups	131.906	2	65.958	.673	0.512
Within groups	13129.197	134	97.979		
Total	13261.113	136			

Not Significant

Table 4.22 shows the ANOVA Table for testing hypothesis six, which states that there is no significant difference in the mean attitude scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy. The result revealed that F136 = .673 with P-Value = .512, P>0.05 level of significant. This made hypothesis six not rejected; that is, there is no significant difference in the mean attitude scores among secondary school students of different ability levels taught algebra using reflective discussion instructional strategy.

4.3 Discussion of Findings

The results of this study have shown that secondary school students taught using the 5Es instructional model had higher mean achievement scores than those taught using the lecture method. This indicated the effectiveness of the 5Es instructional model, which could be as a result of the step-by-step or phase-by-phase presentation of the lesson content to the students, that is from the engagement phase – explanation phase – explanation phase – elaboration phase – evaluation phase. This is in support of the findings of Abu Atta (2013) on the effect of employing learning cycle model in the development of creative thinking skills in mathematics at ninth-grade students in Gaza, Palestine. The study implemented a pilot study on a sample of 28 students studied using

the learning cycle model and another control group composed of 26 students taught using the traditional method; the results of the study showed a significant difference between the two groups in favour of the experimental group. The finding is also in agreement with the result of Abo-Safr (2014), which aimed to know the effect of the employment of two strategies 5Es learning cycle and self Table, in the development of mathematics problem-solving skills at the eighth-grade students in Gaza governorates, Palestine. The effectiveness of the 5Es learning cycle was reported against the lecture method.

Similarly, the result disagrees with the finding of Alebiosu *et al.* (2017) on the investigation of the impact 5Es and PDROD learning models on students' anxiety towards senior secondary chemistry using a quasi-experimental pretest-posttest control group design. A total number of one hundred and eighty-eight students (188) obtained from infect classes of three selected senior secondary schools in south-west Nigeria participated in the study. The result of the study led to the conclusion that exposing students to the PDEODE learning model led to reduced anxiety in chemistry than the 5E learning model and the conventional method. In general, in the experimental group (EXPI), it was examined that students' achievement and attitude increased when taught using 5Es model, their performance in algebra improved and they developed positive attitudes toward algebra. This shows that the results have the same opinion as Salcalli (2011) and Biber and Tuna (2015).

Similarly, the result agreed with the finding of Hamdani (2013), whose work aimed to study the effect of using the Bybee model in the achievement of fifth-grade students in mathematics and the development of formal thinking in Mosul city, Iraq. The study sample consisted of two groups: experimental taught by the Bybee model and control

taught using the traditional method. Results indicated the effectiveness of using Bybee model in the achievement test than those who studied in the traditional method.

It was observed that there was a significant difference between the results of the AAT post test scores of the students taught using SG model and those taught using the traditional method in favour of those in the experimental group. This is similar to the result of Murat and Meryem (2017), whose work investigated the effect of education on mathematical achievement, problem- solving skills and the view of students on the 5E international model and mathematical modelling method for the "Geometric objects" the results of this study revealed that 5Es affected the experimental group achievement positively, this is in agreement with the result reported by Mohammed (2016) who conducted an exploration of the impact of the 5E instructional model on fifth-grade students maths achievement and retention of learning. The researchers randomly chose students at Khaouiss Mushayi province, Saudi Arabia to participate in either experimental or control groups. The experimental group received treatment with 5E constructivist model, while the control group was taught using traditional method. He reported significant differences in achievement between the control group and the experimental group. He concluded that the 5E constructivist model affected the experimental group's tearing.

A significant effect of treatment as found in this study on students achievement in mathematics. This is in support of Omotayo and Adeleke (2017), they conducted a quasi-experimental research to examine differences between the control group mathematics achievement and the treatment group taught using 5E model. The study sample was composed of 155 senior secondary school students in Ibadan metropolis of Oyo state of Nigeria. They found a significant effect of treatment on students' achievement in mathematics. Similarly, the result of this study concord with the result

of Tunaand Kacar (2013), who conducted high school in Turkey in which the effect of 5E model on high school students' mathematics of achievement and retention of their knowledge were examined the treatment group was taught in an environment which the 5E learning model approach was used the control group was taught using traditional method. The two groups were exposed to pretest with similar result however the posttest results of the two groups were significantly different. They conclude that the students taught trigonometry concept using 5E model has a better tearing outcome.

An important finding of this study is the significant difference which exists in attitude scores in posttest between the group taught using 5Es instructional model and the control group taught using the traditional method. This is consistent with the report of Toraman and Demir (2016), whose findings reported significant effects on students' attitudes towards lessons.

This study further revealed that the achievement of students taught using 5Es instructional model were enhanced. This is in line with the findings of Madu and Ezeamagu (2013), who reported that the achievement of pupils in mathematics was enhanced when they were taught in an environment that applied 5E instructional model. Phase positive outcome of using the 5E instructional model could be as a result of their frequent engagement in activities explanations, exploration and contempt evaluation of concept fearret. Findings from this study revealed that students taught using reflective discussion obtained a higher mean achievement score than the control group (Students taught using traditional method). It was inferred that the higher achievement could be as a result of reflective activity introduced in the discussion method; that is, creating time for individual students to read and jot down points, then engaging in group discussion to share ideas and reflect on what was read. This result is in line with the result of Gbamisola (2015), whose study investigated the effectiveness of reflective reciprocal

teaching techniques on student teachers' academic achievement and attitude in economics, four null hypotheses were formulated to guide the study. The findings of the study showed that there exists a significant difference in the achievement of student-teacher in economics when taught using reflective reciprocal teaching strategies compared to the conventional method.

In this study, students taught using the reflective discussion instructional strategy had a higher mean achievement score than those taught using the 5Es instructional model. However, further analysis revealed that there was no significant difference in the mean achievement scores between students taught using the two methods.

Similarly, further analysis revealed that there was significant difference in the mean attitude score in posttest among the three groups in favour of the two experimental groups. However, there was no observed significant difference in the mean attitude scores between experimental group one and experimental group two. This outcome is in agreement with the findings of Awofala *et al.* (2013), carried out to find out the impact of framing and team assisted individualized (TAI) instructional methods. The result revealed a significant main effect of treatment and gender on attitude mean score of subjects exposed to TAI and framing methods. It was concluded that TAI and framing strategies were more effective in promoting students' attitudes toward mathematics and it was suggested that teaching methods can positively change students' attitudes toward mathematics.

This outcome is also in line with the findings of a study carried out by Mata *et al.* (2012) to investigate how certain diverse but interconnected variables like background motivation and social support can lead to clarification of learner attitudes towards mathematics and understanding of the defining factures of these attitudes in the school

environment. The finding indicated positive attitudes towards mathematics and also stressed the main effects of grade and mathematics achievement on the attitudes. This study revealed that reflection action is instrumental in students' achievement and attitude toward algebra. It is in support of Rupnow and Barker (2021) whose work found reflection-in-action instrumental in learning.

The result in this research work indicated that students taught using an effective discussion instructional strategy had higher achievement mean scores than those students taught using traditional method. This is in line with the result of Lia *et al.* (2014), which indicated that the achievement of mathematics intuitive-reflective thinking ability of students who worked under problem-based learning achieved significantly higher than that of students who worked under conventional learning.

It has been observed in this study that reflection practice during learning has a tremendous effect on secondary school students' achievement, This is shown in the ANOVA results when students taught using reflective discussion achieved better result than those taught using traditional methods. This concord with the finding of Rupnow and Barker (2021) whose result suggested a need for exposure to effective practice during learning process.

This study also revealed the efficacy of the 5Es instructional model and reflective discussion instructional strategy on achievement and attitudes towards algebra among secondary school students of different abilities. ANOVA analysis of the scores indicated that there was no significant difference in posttest mean achievement scores among students of high ability, medium ability and low ability taught algebra using 5Es instructional model. Similarly, high-ability, medium-ability and low-ability subjects obtained posttest mean attitude scores. ANOVA analysis revealed that there was no

significant difference in the mean attitude score among students taught using 5Es instructional model (See Table 4.12). This implies that 5Es instructional model is friendly among students of high, medium and low abilities in terms of algebra achievement and attitude towards mathematics among secondary school students.

Consequently, in posttest mean achievement of students taught using reflective discussion instructional strategy, high ability, medium ability and low ability students, ANOVA analysis revealed that there is no significant difference in posttest mean achievement scores among subjects of different ability levels (see Table 4.13). Similarly, high-ability, medium-ability and low-ability subjects had posttest mean attitude scores. ANOVA analysis showed that there was no significant difference in the posttest mean attitude scores among students of different ability levels taught algebra using reflective discussion instructional strategy (see Table 4.14). This is to say that the reflective discussion instructional strategy is not biased among ability levels.

In accordance with the above findings, inadequate research in this area, the researcher saw the need to investigate possible strengths, weaknesses and of course, suggestions to improve the 5Es model and reflective discussion instructional strategy.

4.4 Summary of Major Findings

Based on the results of the data analyzed and presented, the following were the findings revealed;

1. The experimental group two, those taught with reflective discussion instructional strategy, had higher mean achievement scores, which was closely followed by the mean achievement score of experimental group one and the control group obtained the least mean achievement score. Hence, there is a significant difference in the

mean achievement scores among the two experimental groups and the control group.

2. A higher mean attitude score was obtained by experimental group two and the least was obtained by the control group. There is a significant difference in the mean attitude score among the experimental groups and the control group.
3. The mean achievement scores among secondary school students of different ability levels were observed to be similar. Hence, there is no significant difference in the mean achievement scores of secondary school students of different ability levels taught algebra using the 5Es instructional model.
4. The observed mean attitude scores among secondary school students of different abilities were similar; this revealed no significant difference in the mean attitude scores among secondary school students of different ability levels taught algebra using the 5Es instructional model.
5. Hypothesis five was not rejected. This is to say that there is no significant difference in the mean achievement scores of secondary school students with different ability levels taught using reflective discussion instructional strategy.
6. There is no significant difference in the mean attitude scores among secondary school students of different ability levels taught algebra using a reflective discussion strategy. Similar mean scores were observed.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

This chapter presents a report based on conclusion, recommendations, contribution to knowledge and suggestions for further studies.

5.1 Conclusions

Based on the results of this study, it was concluded that both the 5Es instructional model and reflective discussion instructional strategy have positive effects on algebra achievement, and has the capacity to improve algebra achievement and attitude towards algebra among secondary school students in Niger State. The two methods are friendly in terms of ability levels and can bridge the gap of achievement and attitude towards mathematics among secondary school students of different ability levels.

5.2 Recommendations

Based on the findings and conclusions in this study, it is recommended that:

1. Mathematics teachers should employ the 5Es instructional model and reflective discussion instructional strategy in teaching algebra concepts in our secondary schools in Niger State.
2. Learning environment for students should be activity base, for students to be actively involved and share ideas.
3. Mathematics teachers should be aware that the 5Es instructional model and reflective discussion instructional strategy are in favour of mixed ability grouping. It could bridge their gap in achievement.

4. 5Es instructional model and reflective discussion instructional strategy have the potential to improve students' positive attitude toward algebra; this can improve students' performance in mathematics.

5.3 Recommendation for Further Studies

The following are recommendations for further study:

1. Effects of 5Es instructional model and reflective discussion instructional strategy on geometry achievement among secondary school students in Niger State.
2. Effects of 5Es instructional model and reflective discussion instructional strategy on mathematics achievement and interest among secondary school students in Niger State.
3. Impact of reflective discussion strategy on students' Anxiety towards senior secondary mathematics in Niger State.
4. Effects of 5Es model and reflective discussion strategy on mathematics achievement and retention among secondary school students in Niger State.

5.4 Contributions to Knowledge

This study has contributed to knowledge in the following ways;

1. Shows the effects of 5Es instructional model and reflective discussion instructional strategy on algebraic achievement among secondary school students.
2. Reveals the effects of 5Es instructional model and reflective discussion instructional strategy on attitudes towards algebra among secondary school students.
3. Reveals the effects of 5Es instructional model and reflective discussion instructional strategy on algebraic achievement among secondary school students of different ability levels.

4. Reveals the effects of 5Es instructional model and reflective discussion instructional strategy on attitude towards algebra among secondary school students of different ability levels.

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APPENDIX A

Validation Form for ATAI

1. Kindly judge each of the task relevance to the topic "Effects of 5Es model and reflective discussion instructional strategies on Algebra achievement and attitude of senior secondary school students in Niger State, Nigeria.
2. Please indicate your level of judgment based on the following scales by ticking (√) appropriate option based on relevance of each question to the above topic.

   4- Very appropriate 3- Appropriate 2- Not appropriate 1- Very inappropriate
3. Your comments and suggestions are valuable and very much appreciated. Thank you very much sir in anticipation for your contribution.

No	Item	4	3	2	1	Comments/Suggestions
1	Algebra is an interesting area in Mathematics					
2	I need maths in my daily activities					
3	I would like to develop Algebra skills					
4	In my class our teacher is the only person who knows Algebra					
5	I find Algebra boring					
6	Algebra can be used in situation outside classroom					
7	I would always want to learn more about Algebra					
8	Methods that are used in our Mathematics textbooks are the best to solve Algebra problems					
9	I do not like solving Algebra problem on my own					
10	Algebra is not useful to me in anyway					
11	I study Mathematics only when I am going to have					

	a test					
12	I learn Mathematics when I have to revise for test					
13	I always enjoy mathematics lesson					
14	I find Mathematics useful to me in my daily life					
15	I always appreciate more homework in Algebra concepts than any other concepts in mathematics					
16	I only learned Algebra concepts in the class					
17	I wish we were taught Algebra concepts only					
18	I have used my school Algebra concepts experience to solve problem outside the school environment					
19	I will like to study mathematics related concepts in future					
20	For me to do well in Algebra I have to memorize thermos and formulas					

Source: Adapted (a) 2004 David Mogari

Overall Comments/Suggestions:……....

…….

…….

Expert's Signature:…… Expert's Position:……

Expert's Name:…….. Date:…….

APPENDIX B

ATTITUDE TOWARDS ALGEBRA INVENTORY

Dear Respondents,

This questionnaire is designed to elicit responses, opinions and view on the above subject matter. Any information given will be used solely for the purpose of this research and will be treated with utmost confidentiality.

SECTION A

Personal and institutional information

Student Code:_____

Name of School:_____

SECTION B

Please indicate with a tick (√) the extent to which you agree with any of the statement. You are therefore to consider each of the following statements and indicate the response that best reflects your feeling about the statement and select the appropriate option. The options/scales are: SD = Strongly Disagree, D = Disagree, A = Agree and SA = Strongly Agree

S/NO	STATEMENT	4	3	2	1
1	Algebra is an interesting area in Mathematics				
2	I need maths in my daily activities				
3	I would like to develop my Algebra skills				
4	In my class our teacher is the only person who knows Algebra				

5	I find Algebra boring				
6	Algebra can be used in situation outside classroom				
7	I would always want to learn more about Algebra				
8	Methods that are used in our Mathematics textbooks are the best to solve Algebra problems				
9	I do not like solving Algebra problem on my own				
10	Algebra is not useful to me in anyway				
11	I study Mathematics only when I am going to have a test				
12	I learn Mathematics when I have to revise for test				
13	I always enjoy mathematics lesson				
14	I find Mathematics useful to me in my daily life				
15	I always appreciate more homework in Algebra concepts than any other concepts in mathematics				
16	I only learned Algebra concepts in the class				
17	I wish we were taught Algebra concepts only				
18	I have used my school Algebra concepts experience to solve problem outside the school environment				
19	I will like to study mathematics related concepts in future				
20	For me to do well in Algebra I have to memorize thermos and formulas				

APPENDIX C
ALGEBRA ACHIEVEMENT TEST (AAT)

I am a Postgraduate Student of the Department of Science Education, School of Science and Technology Education, Federal University of Technology, Minna. I hereby solicit your response on the test instrument provided below. It is designed to obtain data on algebra achievement by mathematics students. Utmost confidentiality will be adhered to.

Name of school:……. Student Code:……

Instruction: Attempt all questions (Circle the correct answer)

1. Expand (a + 7)(a – 3)

   (a) $2a^2 + 4a + 27$ (b) $a^2 + 4a - 21$ (c) $a – 3a^2 + 9$ (d) $a^2 + 7a + 3$ (e) $a^2 + 2a- 21$

2. Factorize 5x + 5y

   (a) 10x + 10y (b) 10xy (c) 5(x + y) (d) 5xy (e) xy(5)

3. Solve 4x – 20 = 5x – 22

   (a) 2 (b) 4 (c) 5 (d) 21 (e) 22

4. Solve the equation (x – 2)(x + 9) = 0

   (a) 2 or -9 (b) -18 or 1 (c) -9 or 2 (d) -11 or 7 (e) 3 or -2

5. Factorize $x^2 – 9$

   (a) $(x^2 + 3)(x – 1)$ (b) (x – 3)(x – 3) (c) (x + 3)(x + 3) (d) (x + 3)(x – 3 (e) (x-2)(x-3)

6. Factorize $x^2 – 121$

   (a) (x – 11)(x + 11) (b) (x – 121)(x + 121) (c) (x +121)x (d) $(x^2 – 1)(x$ +121)(e) $x^2(-21)$

7. What must be added to $x^2 – 5x$ to make it a perfect square expression?

   (a) 2 (b) $-5/2$ (c) $25/4$ (d) $-25/4$ (e) 25

8. Which of the following term will be added to $y^2 + {}^1/_4y$ to make it a perfect square expression.

   (a) 4 (b) $^1/_{64}$ (c) ¼ (d) $^1/_8$ (e) 64

9. Make the expression $b^2 + {}^1/_2b$ a perfect square.

   (a) $^1/_8$ (b) $^2/_9$ (c) $^1/_{36}$ (d) $^1/_{16}$ (e) 1/16

10. In the expression $4y^2 + y - 1$, what is the coefficient of y^2?

    (a) 2 (b) 4 (c) y (d) xy (e) 4y

11. Given $3y^2 - 2y + 6$, what is the coefficient of the second term?

    (a) 2 (b) 3 (c) 6 (d) -2 (e) 12

12. Which of the followings is algebraic equation

    (a) x + y – 2 (b) $y^2x - x$ (c) 3y – 3x = 5x (d) $^2/_3 + ½ = {}^{10}/_{13}$ (e) xy

13. If $x^2 + 6x + k$ is a perfect square expression what is the value of k.

    (a) 36 (b) 9 (c) 6 (d) 2 (e) 1

14. What must be add to $y^2 + 5y$ to make it a perfect square expression?

    (a) 6¼ (b) 2½ (c) 3 (d) 10 (e) 6¼

15. The equation $x^2 + 8x - 3 = 0$ can be written as the following except.

    (a) $x^2 + 8x = 3$ (b) $8x - 3 = -x^2$ (c) $x^2 = +8x + 3$ (d) $0 = -3 + 8x + x^2$

    (e) x + 3 – 8x =0

16. Solve the equation $x^2 + 4x - 21 = 0$

    (a) 3 & - 7 (b) 4 & 21 (c) 4 (d) 8 (e) -4 & -21

17. Compare $ax^2 + bx + c = 0$ with $3x^2 - 2x - 1 = 0$, What is the value of c?

    (a) 3 (b) -4 (c) 0 (d) -1 (e) 1

18. Given the equation $y + {}^1/_y = 3$, what is the constant term?

    (a) 3 (b) 1 (c) 3 (d) Non of the above (e) y

19. Calculate the value of r in $r^2 - 10r + 15 = 0$

(a) 5 (b) $\sqrt{10} + 5$ (c) $5 \pm \sqrt{10}$ (d) $5\sqrt{10}$ (e) $10 \pm \sqrt{5}$

20. Find the roots of the equation $3x^2 - 4x + 1 = 0$

(a) 1, $^1/_3$ (b) 2, 0 (c) $-^3/_4$, 1 (d) 3, -4 (e)-3,1

21. Which of the following numbers will divide $-2x^2 + 2x - 5 = 0$, to make the coefficient of the first term unity

(a) 2 (b) -2 (c) -5 (d) -2x (e) 4

22. If the roots of $3x^2 + x - 2 = 0$ are α and β, find $\alpha + \beta$

(a) $^1/_3$ (b) 3 (c) -1 (d) $-^1/_3$ (e) 2

23. Construct an equation whose roots are 2 and 3.

(a) $x^2 - 5x + 6 = 0$ (b) $x^2 - 2x + 3 = 0$ (c) $x^2 - x + 30 = 0$ (d) $x^2 + 6x - 5 = 0$ (e) $2x + 3 = 0$

24. If α and β are the roots of $y^2 - 4y + 3 = 0$. Find the value of $2(\alpha - \beta)$.

(a) 2 (b) 4 (c) 6 (d) -2 (e) 12

25. A girl is 6 years younger than her brother, the product of their ages is 135. How old is the girl?

(a) 15 Years (b) 10 Years (c) 21 Years (d) 9 Years (e) 30 Years

26. Which of the followings is not a linear equation.

(a) $x + {}^1/_x - 2 = 0$ (b) $xy + 2 = 0$ (c) $10y + x = 1$ (d) $(2x + y) - y = 0$ (e) $xy + y = 0$

27. Solve the equation $(r - 4)(r + 7) = 0$

(a) -4 & 7 (b) 28 & 0 (c) 4 & -7 (d) 7 & 0 (e) 14 & 21

28. The general form of quadratic equation can be written in the following forms except.

(a) $ax^2 = -bx + c$ (b) $x^2 + {}^b/_a x + {}^c/_a = 0$ (c) $ax^2 + bx = 0$ (d) $ax^2 + bx + c = 0$ (e) $ax^2 + bx = -c$

29. The followings are examples of perfect square quadratic expressions except.

(a) $(x + 3)^2$ (b) $(x – 2)^2$ (c) $(2x + 1)^2$ (d) $(2x^2 + 5x)$ (e) $(x – 3)^2$

30. Given $x^2 – (\alpha+\beta)x + \alpha\beta = 0$ as quadratic equation the coefficient of x is

(a) $\alpha\beta$ (b) $\alpha+\beta$ (c) $-(\alpha+\beta)$ (d) x^2 (e) a - β

ALGEBRA ACHIEVEMENT TEST (AAT) MARKING GUIDE

1. b
2. c
3. a
4. a
5. d
6. a
7. c
8. b
9. e
10. b
11. d
12. c
13. b
14. e
15. c
16. a
17. d
18. b
19. c
20. a
21. b
22. d
23. a
24. b
25. d
26. a
27. c
28. a
29. d
30. c

APPENDIX D
SENIOR SECONDARY SCHOOL TWO (SS II) LESSON ONE (1)
5Es MODEL LESSON PLAN

Name of School:……..

Name of Teacher:…….

Duration of Lesson:……..

Topic: Algebraic Expression

Sub-Topic: Quadratic equation by factorization

Performance Objectives: At the end of the lesson, the students should be able to:

i. Define quadratic equation.
ii. Identify terms in a quadratic equation
iii. Write down coefficient of each term in a given quadratic equation.
iv. Solve quadratic equation by factorization

Materials: 5Es model lesson plan, students team work sheet, individual student evaluation sheet.

Procedures: Teachers and student activities

a. **Teacher Activities:** Planning the lesson

a) Rank students into ability groups using previous grade (scores).
b) Divide the students into teams, assign each student to a team
c) Prepare lesson to teach and draft out students team work sheet and individual student test sheet

d) Insist on the good team spirit by encouraging students to ask teammates for help before asking the teacher.

b. **Teacher & Student Activities:** Implementation.

i. Engagement: (5 Minutes)

The teacher explains the meaning of quadratic equation to the students as an equation that has the highest power of the variable equals two (2). Example is $2x^2 + 5x = 0$. It has $2x^2$, $5x$ as first and second terms respectively and has a constant as -1. The number that comes before a variable is called coefficient, for example in the given equation above, coefficient of x^2 is 2 while coefficient of x = 5. Also note that if a x b = 0, either a or b must be zero (0), hence given that $(x + 1)(x + 2) = 0$

Either	$x + 1 = 0$	or	$x + 2 = 0$
	$x = 0 – 1$		$x = 0 – 2$
	$x = -1$		$x = -2$

ii. **Exploration:(10 Minutes)** This involve team study and monitoring;

a) The teacher gives the students the team work sheet for the students to collectively attempt the work/exercise.

b) The teacher monitor the team work (check if somebody is dominating or not participating)

iii. **Explanation:(3 Minutes)** The teacher;

a) Praise the team who is working well and show others how they are doing it.

b) Each student has to understand the content and demonstrate his/her understanding.

iv. **Elaboration:(10 Minutes)** The teacher;

a) Encourage each group to select a group leader to explain their group work and observation.

b) Asks students to suggest alternative methods of solving quadratic equation.

c) Identifies groups with correct explanation.

v. **Evaluation: (10 Minutes)** The teacher;

a) Make sure each student sits alone for test/quiz.

b) Ensure each student attempt all the questions on the individual student test sheet. They are individually accounTable.

c) Ensure that no student marks his/her quiz script.

d) Ensure student in different teams correct each other's quizzes after receiving the quiz answer sheets.

Conclusion:(2 Minutes) The teacher concludes the lesson by:

i. Revising and briefly summarizes the lesson objective.

ii. Giving an assignment to engage students prior to the next lesson.

STUDENTS' TEAM ACTIVITIES SHEET
5Es MODEL LESSON ONE (1)

Instruction: The activities sheet is designed base on the teachers' lesson presentation, every team member is expected to contribute in solving the problems.

Instruction: Use the spaces provided to answer each of the following questions.

1. Give four (4) examples of a quadratic equation.

   i.

   ii.

   iii.

   iv.

2. Write down the coefficient of the terms in the following equations.

   a. $-3x^2 + 2x - 1 = 0$ b. $-5 + 2x + 5x2 = 0$ c. $2x^2 + x = 1$

   Solution:

   a. Coefficient of (i) $-3x^2$is ..... (ii) 2x is .....

   b. Coefficient of (ii) $5x^2$is .....(ii) 2x is.....

   c. Coefficient of (i) $2x^2$ is .....(ii) x is .....

3. Solve the equations:

   a. $(x + 2)(x - 2) = 0$

   b. b. $(5x + 1)(x - 3) = 0$

4. Solve the equation $x^2 - 10x + 24 = 0$

INDIVIDUAL STUDENTS' EVALUATION SHEET
5Es MODEL LESSON ONE (1)

Student code:.....

Attempt the questions below:

Solve the questions by choosing the correct answer.

1. $(r - 3)(r + 1) = 0$ a. 3 & -1 b. -3 & 1 c. 4 & 2
   d. -2 & 1
2. $(4y + 3)(2y - 1) = 0$ a. 4 & 3 b. -2 & 1 c. ¾ & ½
   d. ¾ & -½
3. $x^2 + 4x = 21$ a. 21 & 4 b. 3 & -7 c. -3 & 21
   d. 4 & 7
4. $2b^2 - 5b + 3 = 0$ a. -7 & 3 b. 2 & 3 c. -3 & 5
   d. 1.5 & 1

Marking guide.

1. a 2. c 3. b 4. d

LESSON TWO (2)
5Es MODEL LESSON PLAN
TOPIC: ALGEBRAIC EXPRESSION SUB TOPIC: QUADRATIC EQUATION

Performance objectives: At the end of the lesson, the students should be able to:

i. Describe a perfect square quadratic equation.

ii. Factorize a perfect square quadratic equation correctly.

iii. Make a quadratic equation a perfect square.

Materials: 5Es model lesson plan, students team work sheet, individual student evaluation sheet.

Procedures: Teacher and students activities.

a. Teacher activities: Planning lesson.
    i. Ensure students maintain their groups.
    ii. Prepare lesson to teach, draft out students team work sheet and individual student test sheet.
    iii. Revise factorization of perfect squares that is $x^2 + 2ax + a^2 = (x + a)^2$
    iv. Guide students to realize that certain quadratic expression can be made perfect square by adding some quantities which is regarded as a constant K.
    v. Leads students to realize that all perfect squares are factorizable.
b. Student activities:
    i. Expands and factorizes perfect squares.
    ii. Follow teachers' example to find constant K that makes quadratic equation perfect squares.

Implementation: Teacher and students activities.

i. Engagement: (5 Minutes)

The teacher leads the students to solve $(x + 2)(x + 2)$ which will give $x^2 + 4x + 4$, also factorize $x^2 + 4x + 4$, gives $(x + 2)(x + 2)$. The teacher then explains that such is perfect square expression.

A perfect square is a quadratic expression that factors into two identical binomials. Example is $(x + 2)(x + 2) = x^2 + 4x + 4$. Also if the factorize $x^2 + 4x + 4$ we get the two identical factors $(x + 2)(x + 2)$, therefore the expression $x^2 + 4x + 4$ is a perfect square since it factors into two identical factors, $x + 2$ and $x + 2$. Note that $(x + 2)(x + 2)$ can be written as $(x + 2)^2$, therefore $x^2 + 4x + 4 = (2 + 2)^2$.

ii. Exploration: (10 Minutes)

This involves team study and monitoring:

a. The teacher team study and monitoring sheet for the students to collectively attempt the work/activities.
b. The teacher monitor the team work and ensure that is participatory by all group members.
c. The teacher lead them to investigate that some quadratic functions can not be factorize.

iii. Explanation: (3 Minutes)

The Teacher;

a. Praise the students whose team is working well and show others how they are solve it.
b. The teacher explains and lead the students to follow guidelines to make a quadratic equation a perfect square.

iv. Elaboration : (10 Minutes)

The Teachers;

a. Encourage each group to explain their group work and observation by a group leader.
b. Identifies groups with best result.

v. Evaluation: (10 Minutes)

a. Make sure each student sits alone for quiz.
b. Ensure each student attempt all the questions on the individual student quiz sheet.
c. Ensure that no student marks his/her quiz script.

vi. Conclusion: (2 Minutes)

The Teacher;

a. Revises and briefly summarizes the lesson objectives.
b. Gives an assignment to engage students prior to the next lesson.

STUDENTS' TEAM ACTIVITIES SHEET
5Es MODEL LESSON TWO (2)

Introduction: The activities sheet is designed based on the teachers' lesson presentation, team member is expected to contribute in solving the problems.

Instructions: Use the spaces provided to answer each of the following questions.

1. Factorize the followings and note your observation.
   a. $x^2 + 10x + 25$

   b. $x^2 – 6x + 9$

   c. $x^2 + 6x + 9$

   d. $x^2 + 8x + 3$

   e. $2x^2 + 13 – 15$

To make an equation a perfect square add the square of half of the coefficient of x.

Example: Ask Students to make $x^2 – 6x$ a perfect square.

2. Add the number that makes each of the given expression a perfect square.
   a. $x^2 + 2x$ b. $x^2 + 7x$

INDIVIDUAL STUDENTS' QUIZ SHEET
5Es MODEL LESSON TWO (2)

Student code:.....

Attempt the questions below.

1. a. Solve $(x + 4)(x + 4)$

   b. Expand $(x - 1)^2$

   c. Make the expression $x^2 - 10x$ a perfect square.

Marking guide.

a. $x^2 + 8x + 16$ b. $x^2 - 2x + 1$ c. $x^2 - 10x + 25$

LESSON (3)
5Es MODEL LESSON PLAN
TOPIC: ALGEBRAIC EXPRESSION SUB-TOPIC: QUADRATIC EQUATION.
Performance Objectives: At the end of the lesson, the students should be able to:

i. Solve quadratic equation by method of completing the square.

ii. Deduce and apply the quadratic formular in solving quadratic equation problem.

Materials: 5Es model lesson plan, students' team work sheet, individual student quiz sheet.

Procedures: Teacher and students activities.

a. Teacher activities;

(i) Planning the lesson (ii) Ensure students maintain their groups (iii) Guides students in the steps involved in solving quadratic equation using completing the square method. (iv) Guide using the completing square method to solve the general form of quadratic equation, given as; $ax^2 + bx + x = 0$

Guide students in applying the formular to solve some problems

b. Students activities;

i. Contribute in the team work.

ii. Participate in solving quadratic equation by completing the square method.

iii. Deduce the quadratic formula form the method of completing squares.

iv. Apply the fornula in solving some problems.

Implementation: Teacher and students activities.

a. Engagement: (5 Minutes)

The teacher asks the students to factorize $x^2 + 5x + 2 = 0$, which is not possible. He/she now lead them to solve by following the steps below; since the left hand side does not factorize, take the constant term to the right hand side given $x^2 + 5x = -2$

Make the left hand side a perfect square by adding the square of half of the coefficient of x. coefficient of x = 5

$(^5/_2)^2 = \frac{25}{4}$ $\qquad$ $x^2 + 5x + \frac{25}{4} = -2 + \frac{25}{4}$

Factorize left hand side which is now a perfect square.

$(x + ^5/_2)^2 = -2 + \frac{25}{4}$

Simplify $(x + ^5/_2)^2 = -8 + \frac{25}{4}$

$(x + ^5/_2)^2 = \frac{17}{4}$ $\qquad$ $x + ^5/_2 = + \sqrt{\frac{17}{4}}$ $\qquad$ $x = -^5/_2 + \sqrt{\frac{17}{4}}$

$= -^5/_2 + \sqrt{\frac{17}{2}}$

This is referred to as completing the square method.

a. Exploration: (10 Minutes)

i. The teacher encourage the students to solve problems given in the team works sheet.

ii. The teacher monitor the team work and ensure that is participatory by all the group members.

iii. The teacher lead the students to observed that no need of using completing square method if the equation can be factorize.

iv. The teacher make sure that factorizable equation is included in the exercise, so that the students can observe (iii) above.

b. Explanation (3 Minutes)

i. The teacher (i) Ensure that the activities are attempted and students are getting it.

ii. Encourage other groups not getting it are updated.

iii. The teacher encourage the best group and motivate the entire class with praises.

c. Elaboration: (10 Minutes)

The teacher;

i. Encourage students to solve $ax^2 + bx + c = 0$ by completing the square.

ii. He/she lead the students to deduce the quadratic formula: $\frac{x = -b \pm \sqrt{b^2 - 4ac}}{2a}$

iii. Lead the students to apply it in solving problems.

d. Evaluation: (10 Minutes)

The teacher;

i. Ensure each student attempt the quiz independently.

ii. Observe their performance and comments.

iii. Ensure no student mark his/her quiz.

e. Conclusion: (2 Minutes)

The teacher;

i. Revise and summarizes the lesson objectives.

ii. Gives an assignment to engage the students at home.

STUDENTS' TEAM ACTIVITIES SHEET
5Es MODEL LESSON THREE (3)

Introduction:

The activities sheet is designed based on the teachers' lesson presentation, every team member is expected to contribute in solving the problems.

Instructions: Use the spaces provided to solve each of the following question. You must finish section 'A' before moving to 'B.

Section 'A': Solve by completing the square method.

i. $x^2 + 3x - 2 = 0$

ii. $x^2 - 10x + 25 = 0$

iii. $x^2 - 7x + 11 = 0$

Section 'B': (i) Solve $ax^2 + bx + c = 0$ by completing the square.

(ii) Solve $x^2 - 4x + 3 = 0$ using quadratic formular.

INDIVIDUAL STUDENTS' QUIZ SHEET
5Es LESSON THREE (3)

Student code.....

Attempt the questions below:-

a. Solve by completing the square.

   $x^2 - 7x + 10 = 0$

b. Compare $3x^2 - 9x + 5 = 0$ with $ax^2 + bx + c = 0$, write down the values of a, b & c.

Making guide.

a. x = 2 or 5

b. a = 3, b = -9, c = 5

LESSON FOUR (4)
5Es MODEL LESSON PLAN
TOPIC: ALGEBRAIC EXPRESSION SUB-TOPIC: QUADRATIC EQUATION

Performance Objectives: At the end of the lesson, the student should be able to:

i. Find the sum and product of a quadratic equation without solving it.

ii. Form quadratic equations using sum and product of the given roots.

Materials: 5Es model lesson plan, students' team work sheet, individual student quiz sheet.

Procedures: Teacher and students activities.

a. **Teacher Activities:** The teacher.
    i. Prepare the lesson to teach.
    ii. Ensure students maintain their groups.
    iii. Guides students in the steps involved in the lesson.
    iv. Guide students in steps involved in the formation of quadratic equation using sum and product of roots.
    v. Draft out worksheets and answers, quiz and answers.
b. **Students Activities:** The students.
    i. Contribute in the team work.
    ii. Form quadratic equation using sum and product of the given roots.
    iii. Participate fully in solving problems given on the work sheet.
    iv. Attempt the quiz and demonstrate skills acquired.

Implementation: Teacher and student activities.

a. Engagement: (5 Minutes)

The Teacher

i. Gives students problems to solve involving quadratic equation by formular.

ii. Monitor the activities.

iii. Ensure the students' proficiency in solving the problem.

b. Exploration: (10 Minutes)

The Teacher;

i. Leads the students on how they can apply knowledge gained to find sum and product of given quadratic equation.

ii. Explain how sum and product of roofs can be find.

iii. Ensure students follows the guide lines.

iv. Draw students attention to their worksheet.

v. Guide the students to solve the activities on the their worksheet.

c. Explanation: (3 Minutes)

The Teacher;

i. Ensure that the activities are completed by the students.

ii. Encourage each group to summarize their work and presents theory the group leader.

iii. Explain necessary steps missing or misunderstood.

d. Elaboration: (10 Minutes)

The Teacher;

i. Encourage students to attempt activities on phase two of team worksheet.

ii. Lead students to form quadratic equation given sum and products of the roots.

e. Evaluation: (10 Minutes)

The Teacher

i. Ensure students attempt quiz independently.

ii. Coordinate marking activates and assess them.

iii. Observe their performance and make comment.

f. Conclusion: (2 Minutes)

The Teacher;

i. Summarizes the lesson objectives.

ii. Comment but avoid condemnation statements on students.

iii. Gives assignments.

STUDENTS' TEAM WORK SHEET
5Es MODEL LESSON FOUR (4)

Introduction: The activities sheet is designed based on the teachers' lesson presentation. Every students are expected to contribute to the solving of the activities.

Instruction: Use the spaces provided to solve each of the following questions. The works are divided into two phases, follow teachers' instruction to attempt the questions.

Phase I: Sum and product of roots of quadratic equation.

Note;The roots of an equation are the values of the unknown that makes the equation true. Example $x^2 - 6x - 7 = 0$ has the roots 7 or -1.

i. Let roots of an equation be α and β in x.

   Means $(x - \alpha)(x - \beta) = 0$ .....

   Expand equation 1

ii. Find the sums and products of the roots of

   a. $3x^2 + x - 4 = 0$

   b. $y^2 + 5y = 1$

Phase II: Form equation given sum and product of roots.

Attempt the followings.

1. If the sum and product of roots of an equation is $^3/_2$ and $-^5/_2$ respectively, form the equation in the form $ax^2 + bx + c = 0$

2. Form the equation whose sum and product of roots are respectively given as.

   a. ½ and -2/3 b. 6 and 4 c. 0.2 and 8.1

INDIVIDUAL STUDENTS' QUIZ SHEET

Student code:.....

Attempt the questions below.

1. Given that sum of roots is $^4/_5$ and product of roots is $^1/_3$, find the quadratic equation in the form $ax^2 + bx + c = 0$.

2. Find the sum and product of the equation.

   a. $x^2 - x + 1 = 0$

   b. $2x^2 - 5x + 3 = 0$

Marking guide.

1. $15x^2 - 12x + 5 = 0$ 2. a. $\alpha + \beta = 1$, $\alpha\beta = 1$ b. $\alpha + \beta = 5/2$, $\alpha\beta = 3/2$

APPENDIX E

SENIOR SECONDARY SCHOOL YEAR TWO (SS II) LESSON (1)
REFLECTIVE DISCUSSION (RD) STRATEGY LESSON PLAN

Name of School:……

Class:……

Name of Teacher:…….

TOPIC: ALGEBRAIC PROCESSES SUBTOPIC: QUADRATIC EQUATIONS DURATION: 40 MINUTES

	1	2	3	4	5
	Pre-entry Performance	**Performance Objectives**	**Instructional Materials/Reference**	**Pre-Lesson Activity**	
	The teacher asks the students to; i. Identify a variable in a given example of linear equation. ii. Mention more examples of an	At the end of the lesson, students should be able to; i. Define quadratic equation correctly. ii. Identify terms in a given quadratic equation iii. Write down coefficient of each term in a given quadratic equation	i. Reflective discussion (RD) lesson plan ii. New General mathematics for senior secondary schools 2, MF macral et al, 4th Ed. Longman. iii. Brain builders A1 in mathematics 2nd Ed.	The teacher should; i. Rank students working to their ability using past score. ii. Assign them to a discussion group of not more than (6) students. iii. Preface lesson and other materials needed for	Each student; i. Must be assigned to a discussion group ii. Should pay attention and follow procedure prepared by the teacher iii. Must work within the given time frame

	equation	iv. Solve quadratic equation by factorization method correctly.	2014, Ayodele O. A iv. Poster showing the quadratic formular v. Students' group discussion activities sheet vi. Individual evaluation sheet	assessment iv. Outline the activities for students to follow v. Prepare content text forstudebts	iv. Must abide by the instructions and be ready to work as a group Must study, the text and understand the lesson content and be able to apply it where necessary

LESSON PRESENTATION/IMPLEMENTATION

Time	**5 Minutes**	**10 Minutes**	**10 Minutes**	**3 Minutes**	**10 Minutes**	**2 Minutes**
	Teacher Presentation	**Individual Study**	**Team Study**	**Teacher/Students**	**Evaluation**	**Conclusion**
	The teacher i. Guides the students in identifying variable in a given examples of linear equations ii. Gives more examples of linear equations	1. The teacher distributes the content text to each students. 2. Ensure that each student study the text. 3. Each student jot down ideas from the text	1. The teacher ensures that students are in their respective discussion group 2. Gives each group two copies of the SDGAS and the SDGAS 3. Ensure team members discuss the ideas from the context test 4. Ensure every student understand the content	Discussion the teacher i. Clarifying misunderstood concepts ii. Ensure every students participation and demonstration of his/her understanding	i. The teacher ensures that every student sits alone for the quiz. ii. Every student is given the ISES containing objective question iii. Every students attempt the question provided in the ISES iv. Student marks each other script and on no account should any student mark his/her quiz v. Teacher discuss corrections with the students	The teacher concede the lesson by: 1. Revising and summarizes the lesson objectives. 2. Giving an assignment relating to the concept of the next lesson.

CONCEPT TEXT FOR REFLECTIVE DISCUSSION GROUP

Lesson 1:

Algebraic sentence containing an equals sign, is called an equation. For instance $2x^2 + 5x - 1 = 0$ is an example of an equation. $2x^2$ is referred to as first term, 5x, second term and -1 third term also called the constant term. The variable is x, also called an unknown number, if the highest power of an equation equals two, it is called a quadratic equation, the above equation is an example. The value 2 and 5 are called coefficient of first and second terms respectively. To solve an equation means to find the value of the unknown. There are different methods of solving quadratic equation, these includes:

1. Factorization Method
2. Completing the square method
3. Formular Method
4. Graph Method

Our concern in this present lesson is how to solve quadratic equation by factorization method.

Procedure: We recall that if the product of two real numbers is 0, then one of the number or both must be 0, in general, if a x b = 0 either a = 0 or b = 0. Therefore if (x + 1)(x + 2) = 0, then either x + 1 = 0 or x + 2 = 0

$$x = 0 - 1 \qquad x = 0 - 2$$

$$= -1 \qquad = -2$$

To solve a quadratic equation by factorization method, first, make the equation a product of two linear factors and solve, as demonstrated above.

Example

Solve the equation $x^2 – 5x + 6 = 0$

Solution: Think of two numbers that you can add to get -5 and multiply to get + 6, of course is -3, -2 then rewrite $x^2 – 3x – 2x + 6 = 0$

$(x^2 – 3x)-(2x – 6) = 0$ collect common factors

$x(x – 3) -2(x – 3) = 0$ add terms outside brackets and multiply it with any of the factors in brackets.

$(x – 2)(x – 3) = 0$

:- Either $x – 2 = 0$ or $x – 3 = 0$

$x = 0 + 2$ or $x = 0 + 3$

$= 2$ $= 3$

STUDENTS DISCUSSION GROUP ACTIVITIES

Sheet for Lesson 1

Introduction:- The activities sheet is designed based on the teachers" lesson presentation every discussion group member is expected to contribute in solving the problems.

Instructions:- Use the spaces provided to answer each of the following questions.

Duration:

1. Give four (4) examples of a quadratic equation.

   (i) (ii)

   (ii) (iv)

2. Write down the coefficient of the terms in the following equations.

   a. $-3x^2 + 2x - 1 = 0$;

   b. $-5 + 2x + 5x^2 = 0$;

   c. $2x^2 + x = 1$

Solution:

a. Coefficient of (i) $-3x^2$ is ……

   (ii) 2x is……

b. Coefficient of (i) $+5x^2$ is…….

   (ii) +2x is ……..

c. Coefficient of (i) $2x^2$ is……

   (ii) x is……

3. Solve the equations:

   a. $(x + 2)(x - 2) = 0$

……

……

……

……

……

   b. $(5x + 1)(x - 3) = 0$

……

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……

4. Solve the equation $x^2 - 10x + 24 = 0$

……

……

……

……

……

INDIVIDUAL STUDENTS EVALUATION SHEET
LESSON ONE (1)

Student code:……..……..

Attempt the questions below:

Solve the equations below and choose the correct answer.

1. $(r – 3)(r + 1) = 0$ (a) 3 & -1 (b) -3 & 1 (c) 4 and 2 (d) -2 & 1

……

……

2. $(4y + 3)(2y – 1) = 0$ (a) 4 & 3 (b) -2 & 1 (c) -¾ & ½ (d) ¾ & -½

……

……

3. $x^2 + 4x = 21$ (a) 21 & 4 (b) 3 & -7 (c) -3 & 21 (d) 4,7

……

……

4. $2b^2 – 5b + 3 = 0$ (a) -7 & 3 (b) 2 & 3 (c) -3 & 5 (d) 1.5 & 1

……

……

Marking guide

1. a 2. c 3. b 4. d

SENIOR SECONDARY SCHOOL YEAR TWO (SS II) LESSON TWO (2) REFLECTIVE DISCUSSION (RD) STRATEGY LESSON PLAN

Name of School:……

Class:……

Name of Teacher:…….

TOPIC: QUADRATIC EQUATION SUBTOPIC: PERFECT SQUARE QUADRATIC EQUATION DURATION: 40 MINUTES

	1	2	3	4	5
	Pre-entry Performance	**Performance Objectives**	**Instructional Materials/Reference**	**Pre-Lesson Activity**	
	The teacher askes the students to; i. Give examples of quadratic equation ii. Solve atleast an example of quadratic equation by factorization	At the end of the lesson, students should be able to; i. Describe a perfect square quadratic equation ii. Factorize a perfect square quadratic equation correctly. iii. Make a quadratic equation a perfect square	i. Reflective Discussion (RD) lesson plan\ ii. Students Discussion Group activities sheet. iii. Individual student quiz sheet. iv. Test material on the topic (content) vii. Text book.	The teacher should; i. Ensure students maintain their groups. ii. Prepare lesson to teach, draft out students discussion group activity sheet, individual student quiz sheet. iii. Revise factorization of perfect squares $x^2 + 2ax + a^2 = (x + a)^2$	Each student; i. Must contribute to the group activities ii. Must study the text provided and understand the lesson content. iii. Must attempt the quiz independently. v. Follow teachers' example to find

				iv. Lead students to realize that certain quadratic expression can be made perfect square by adding some quantities which is regarded as a constant K. v. Guide students to observe that all perfect squares are factorizable.	constant K that makes quadratic perfect square.

LESSON PRESENTATION/IMPLEMENTATION						
Time	**5 Minutes**	**10 Minutes**	**10 Minutes**	**3 Minutes**	**10 Minutes**	**2 Minutes**
	Teacher Presentation	**Individual Study**	**Team Study**	**Teacher/Students** Discussion	**Evaluation**	**Conclusion**
	The teacher 1. Guides the students to solve quadratic equation using factorization method 2. Maintain more examples of quadratic equations,	1. The teacher ensures each student has the context 2. Ensure that each student study the text 4. Make sure that students tot down points.	1. The teacher ensures that students are in their groups 2. Discuss and share ideas on jotted points. 3. Ensure every students contribute in solving problems on the discussion sheet. 4. Ensure students understand the concept learnt.	The teacher i. Clarifyingfacts ii. Ensures every students participate and demonstrate his/her understanding.	The teacher i. Ensures that each students attempt the quiz independently. ii. Makes sure that no student mark his/her script.	The teacher revises and summarizes the concept taught, gives assignment to students.

CONTENT TEXT FOR REFLECTIVE DISCUSSION GROUP
LESSON TWO (2)
PERFECT SQUARE QUADRATIC EQUATION

The expression $(x + 2)(x + 2)$ can be expanded as $x^2 + 4x + 4$, also factorize $x^2 + 4x + 4$ gives $(x + 2)(x + 2)$. Equations of this is called perfect square equations.

Therefore a perfect square is a quadratic expression that factors into two identical binomials. Examples $(x + 2)(x + 2) = x^2 + 4x + 4$ and if $x^2 + 4x + 4$ is factorized, we get the two identical factors $(x + 2)(x + 2)$, hence $x^2 + 4x + 4$ is a perfect square.

Note: $(x + 2)(x + 2)$ can be written as $(x + 2)^2$, therefore $x^2 + 4x + 4 = (x + 2)^2$.

It is possible to make an expression a perfect square.

Note: In general, we add the square of half of the coefficient of x to make it a perfect square.

For example, given $x^2 – 6x$, the coefficient of $x = -6 :- -6/2 = (-3)^2 = 9$ hence for $x^2 – 6x$ to be a perfect square quadratic expression, 9 must be added. $x^2 – 6x + 9 = (x – 3)(x – 3)$.

STUDENTS DISCUSSION GROUP SHEET
LESSON TWO (2)

Introduction: The activities sheet is designed based on the teachers' lesson presentation, every team member must contribute in sovling the problems.

Instructions: Use the spaces provided to answer each of the following questions, note your observation.

1. Factorize the followings.
   a. $x^2 + 10x + 25$
   b. $x^2 + 6x + 9$
   c. $x^2 + 8x + 3$
   d. $2x^2 + 13 - 15$
2. Add the number that makes each of the given expression a perfect square.
   a. $x^2 + 2x$ b. $x^2 + 7x$

INDIVIDUAL STUDENT QUIZ SHEET
R.D LESSON PLAN TWO (2)

Student code:.....

Attempt the questions below.

1. a. Solve $(x + 4)(x + 4)$

   b. Expand $(x – 1)^2$

   c. Make the expression $x^2 – 10x$ a perfect square.

Marking guide.

a. $x^2 + 8x + 16$ b. $x^2 – 2x + 1$ c. $x^2 – 10x + 25$

SENIOR SECONDARY SCHOOL YEAR TWO (SS II) LESSON THREE (3) REFLECTIVE DISCUSSION (RD) STRATEGY LESSON PLAN

Name of School:……

Class:……

Name of Teacher:…….

TOPIC: QUADRATIC EQUATION SUBTOPIC: SOLVING QUADRATIC EQUATION BY COMPLETING SQUARE

DURATION: 40 MINUTES

	1	2	3	4	5
	Pre-entry Performance	**Performance Objectives**	**Instructional Materials/Reference**	**Pre-Lesson Activity**	
	The teacher asks the students to; i. Recall the meaning of perfect square quadratic equation ii. Give examples of quadratic equation	At the end of the lesson, students should be able to; i. Solve quadratic equation by method of completing the square. ii. Deduce and apply the quadratic formular in solving quadratic equation problems.	i. Reflective Discussion (RD) lesson plan ii. Students Discussion Group activities sheet. iii. Individual student quiz sheet. iv. Test material on the topic (content) v. Text book.	The teacher should; i. Ensure students maintain their groups. ii. Prepare lesson to teach, draft out students a. Discussion group activity sheet, b. Individual student quiz sheet. iii. Guide students on the steps involved in solving quadratic equation using completing the	Each student; i. Must contribute to the group activities ii. Must study the text provided and understand the content of the lesson. iii. Must attempt the quiz independently. iv. Must follow teacher's instruction.

				square method. iv. Guide students to deduce the quadratic formular using the completing square method to solve the general form of quadratic equation, given as: $ax^2 + bx + c = 0$. v. Guide students in applying the formular to solve problems.	v. Must participate in a. Solving quadratic equation by completing the square b. Deduce the quadratic formular and c. Apply the formular is solving quadratic problem

LESSON PRESENTATION/IMPLEMENTATION						
Time	**5 Minutes**	**10 Minutes**	**10 Minutes**	**3 Minutes**	**10 Minutes**	**2 Minutes**
	Teacher Presentation	**Individual Study**	**Team Study**	**Teacher/Students**	**Evaluation**	**Conclusion**
	The teacher i. Leads the students to solve $x^2 + 5x + 2 = 0$ by factorization which is not possible.	i. The teacher ensures a. Each student has the content text b. Each student study the text c. Each student jotdown points	i. The teacher ensures a. Student are in their groups b. Discuss and share ideas on jotted points c. Each student contribute in solving problems on the activities sheet. d. Student understand the concept learnt	Discussion the teacher i. Clarifying facts ii. Ensures every students participate and demonstrate his/her understanding.	The teacher ensures a. Students attempt the quiz independently. b. Makes sure that no student mark his/her script. c. Comments on their general performance	The teacher revises and summarizes the concept taught, gives assignment to students.

CONTENT TEXT FOR REFLECTIVE DISCUSSION GROUP
LESSON THREE (3)

Completing square method of solving quadratic equation

To solve a quadratic equation, say $x^2 + 5x + 2 = 0$ by method of completing the square, follow the steps below;

Note: $x^2 + 5x + 2 = 0$ is not a perfect square quadratic equation and therefore can not be factorized given $x^2 + 5x + 2 = 0$.

Take the constant term (2) to the right hand side, $x^2 + 5x = -2$

Make the left hand side a perfect square by adding the square of half of the coefficient of x.

Coefficient of x = 5

$(^5/_2)^2 = \frac{25}{4}$ $\qquad$ $x^2 + 5x + \frac{25}{4} = -2 + \frac{25}{4}$

Factorize left hand side which is now a perfect square.

$(x + {}^5/_2)^2 = -2 + \frac{25}{4}$

Simplify $(x + {}^5/_2)^2 = -8 + \frac{25}{4}$

$(x + {}^5/_2)^2 = \frac{17}{4}$ $\qquad$ $x + 5/2 = + \frac{17}{4}$ $\qquad$ $x = -5/2 + \frac{17}{4}$

$= -5 + 17$

If we follow the steps below

In solving the general form of quadratic equation $ax^2 + bx + c = 0$, we realized the quadratic formular is formed as

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

STUDENTS DISCUSSION GROUP SHEET
LESSON THREE (3)

Instruction: The activities sheet is designed based on teachers' lesson presentation, every team member is expected to contribute in solving the problems.

Instructions: Use the spaces provided to solve each of the following questions. You must finish section 'A' before moving to 'B'.

Section 'A': Solve by completing the square method.

1. $x^2 + 3x - 2 = 0$
2. $x^2 - 10x + 25 = 0$
3. $x^2 - 7x + 11 = 0$

Section 'B':

1. Solve $ax^2 + bx + c = 0$ by completing the square.
2. Solve $x^2 - 4x + 3 = 0$ by formular.

INDIVIDUAL STUDENTS' QUIZ SHEET
REFLECTIVE DISCUSSION LESSON THREE (3)

Student code:.....

Attempt the questions below:-

a. Solve by completing the square $x^2 - 7x + 10 = 0$

b. Compare $3x^2 - 9x + 5 = 0$ with $ax^2 + bx + c = 0$ write down the values of a, b, & c.

Marking guide.

a. x = 2 or 5 b. a = 3 b = -9 c= 5

SENIOR SECONDARY SCHOOL YEAR TWO (SS II) LESSON FOUR (4) REFLECTIVE DISCUSSION (RD) STRATEGY LESSON PLAN

Name of School:……

Class:……

Name of Teacher:…….

TOPIC: QUADRATIC EQUATION SUBTOPIC: SUM AND PRODUCT OF QUADRATIC EQUATION DURATION: 40 MINUTES

	1	2	3	4	5
	Pre-entry Performance	**Performance Objectives**	**Instructional Materials/Reference**	**Pre-Lesson Activity**	
	The teacher asks the students to; i. Recall the general form of quadratic equation. ii. Recall the general formular for solving quadratic equation.	At the end of the lesson, students should be able to; i. findthe sum and product of a quadratic equation without solving it. i. formquadratic equation with a given sum and product of the roots.	i. Reflective Discussion (RD) lesson plan ii. Students Discussion Group activities sheet. iii. Individual student quiz sheet. iv. Context test material on the topic v. Text book.	The teacher should; i. Ensures students commitment to group work ii. Prepare lesson to teach, draft out a. Students' discussion group activities b. Individual students' quiz sheet	Each student; i. Must contribute to the group activities ii. Must study the text provided iii. Will demonstrate application of skill

				vi. Guide students on the steps involved in finding sum and product of roots of quadratic equation vii. Monitor commitment of students in their group work.	learnt. iv. Attempt the quiz.
LESSON PRESENTATION/IMPLEMENTATION					
Time	**5 Minutes**	**10 Minutes**	**10 Minutes**	**3 Minutes**	**10 Minutes**	**2 Minutes**
	Teacher Presentation	**Individual Study**	**Team Study**	**Teacher/Students**	**Evaluation**	**Conclusion**
	The teacher i. Leads the students to recall roots of quadratic equation been two (2) ii. Represents the roots with α and β	The teacher ensures i. Each student has the content text. ii. Each student study the text iii. Each student jotdown points	The teacher makesensures that: i. Students are in their respective group ii. Discuss and share ideas on points jotted down. iii. Each student participate in the group activities. iv. Each student understand the concept	Discussion the teacher i. Clarify facts ii. Ensure students demonstrate understating of the concept.	The teacher ensures i. Each student attempted the quiz independently. ii. Make sure that no student mark his/her script. iii. Comments on their general performance	The teacher revises and summarizes the concept taught, gives assignment to students.

CONTENT TEXT FOR REFLECTIVE DISCUSSION GROUP
LESSON FOUR (4)

Sum and product of roots of quadratic equation. We observed from our work so far, that the roots of an equation are the values of the unknown that makes the equation true. Example $x^2 – bx – 7 = 0$ has the roots 7 or -1 which represent the roots of the equation.

Let the roots of an equation be represented by α and β in x, means $(x –α)(x –β) = 0$ .....1 expand equation (1) we have

$x^2 – αx – βx + αβ + αβ = 0$, factorize x out

$x^2 – (α + β)x + αβ = 0$ 2

In equation (2), we can see that $(α + β)$ is sum of the roots and αβ is the product of the roots.

Therefore, when ever the sum and product of roots of a quadratic equation is given, we substitute into equation (2) above to get of equation also given a quadratic equation, the sum and product of the roots can be find without solving it.

STUDENTS' DISCUSSION GROUP SHEET
LESSON FOUR (4)

Introduction: The activities sheet is designed based on the teachers' lesson presentation each student is expected to participate and contribute in the group work.

Instruction: Use the spaces provided to solve each of the following questions.

1. Find the sum and products of the roots of:
   a. $3x^2 + x - 4 = 0$
   b. $y^2 + 5y = 1$
2. Form the equation given sum and product of roots as 3/2 and -5/2 respectively. Write the equation in the form ax2 + bx + c = 0.
3. Form the equation whose sum and product of roots are respectively givens as
   a. ½ and -2/3 b. 6 and 4 c. 0.2 and 8.1

STUDENTS' INDIVIDUAL QUIZ SHEET

Student code:.....

Attempt the questions below.

1. Given that sum of roots is 4/5 and product of roots is 1/3. Find the quadratic equation in the form $ax^2 + bx + c = 0$

2. Find the sum and product of roots of the equation.
   a. $x^2 – x + 1 = 0$

   b. $2x^2 – 5x + 3 = 0$

Marking guide.

1. $15x^2 – 12x + 5 = 0$ 2. a. sum = 1 product = 1 b. sum = 5/2 product = $^3/_2$

APPENDIX F
SENIOR SECONDARY SCHOOL TWO (SS II) LESSON (1)
CONVENTIONAL METHOD (CONTROL GROUP)

Name of School…….

Name of Teacher…….

Duration of Lesson……..

Topic: Algebraic Expression

Sub-Total:- Quadratic Equation by factorization

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

i. Define quadratic equation.
ii. Identify terms in a quadratic equation
iii. Write down coefficient of each term in a given quadratic equation
iv. Solve quadratic equation by factorization.

Materials: Lesson plan, chalk board, text book

PREVIOUS KNOWLEDGE: Students have been taught linear equation at SSI

INTRODUCTION: Teacher introduces his lesson by asking the students to give examples of linear equation and how to find the variable.

PRESENTATION: The teacher presents his/her lesson by following the steps below>

STEP I: The teacher defines quadratic equation as follows; quadratic equation is an equation that has the highest power of the variable equals two (2). Example $2x^2 + 5x - 1 = 0$

STEP II: The teacher explains to the student's terms in a quadratic equation; in the example above, $2x^2$ is the first term, 5x is the second term while -1 is the constant term.

STEP III: The teacher explains the meaning of coefficient to the students; the number that comes before a variable is called coefficient. For example, 2 is the coefficient of x^2 in the term $2x^2$, while in the term 5x, 5 is the coefficient of x.

STEP IV: The teacher explains the process of factorization method as given ax b = o either a or b is zero (o) or both, hence given (x+1)(x+2)=0, either s+1=0 or x+2=0 and x =0-1 or x =0-2

:- x = -1 or x = -2

Evaluation:- The teacher evaluates his lesson by asking the students questions base on the objective. Therefore the teacher asked the students to:

(i) Give four examples of quadratic equation.

(ii) Write down coefficient of the terms in the following equations a. $-3x^2 + 2x - 1=0$ b. $-5 + 2x + 5x^2 = 0$ c. $2x^2 + x = 1$

Conclusion: The teacher concludes his/her lesson by summarizing what he/she has taught and makes necessary corrections from the evaluation and gives assignment.

Question: Solve the equation $x^2 - 10x + 24 = 0$

APPENDIX G
PERCENTAGE OF STUDENT IN NIGERIA THAT OBTAINED CREDIT AND ABOVE (A_1-C_6), PASS AND BELOW (D_7-F_9) IN THE MAY/JUNE WASSCE IN GENERAL MATHEMATICS BETWEEN 2010 TO 2017

Year	Total No. who sat for the examination	No. of students that obtained Credit and above (A_1-C_6)	% of Students with credit and above (A_1-C_6)	No. of students that got (D_7-F_9)	% of student with (D_7-F_9)
2012	1,675,224	819,390	49.00	852,834	51.00
2013	1,543,683	555,726	36.00	987,957	64.00
2014	1,692,435	555,726	31.30	1,162,703	68.70
2015	1,593,442	529,732	34.18	1,048,804	65.82
2016	1,544,235	597,310	38.68	946,924	61.32
2017	1,563,342	120,504	38.33	1,442,838	61.67
			Mean % = 37.92		Mean % = 62.08

Source: Test and Development Division, West African Examination Council (WAEC)

LAGOS

Table 1.1. Above shows that 37.92% of the Students that sat for SSCE/WASSCE in Nigeria obtained credit and above (A_1-C_6) While 62.08% had pass and below (D_7-F_9) in the may/June WASSCE in general mathematics.

APPENDIX H

Sample discussion groups in classes

student's Discussion Groups in GSS Kwakuti

student's Discussion Groups in GSS Kwakuti

Student's Discussion Groups in GSS Tungan Mallam

student's Discussion Groups in GSS Zungeru

APPENDIX I

EDUCATIONAL AND PSYCHOLOGICAL MEASUREMENT
1970, 30, 607-610.

DETERMINING SAMPLE SIZE FOR RESEARCH ACTIVITIES

ROBERT V. KREJCIE
University of Minnesota, Duluth
DARYLE W. MORGAN
Texas A. & M. University

The ever increasing demand for research has created a need for an efficient method of

determining the sample size needed to be representative of a given population. In the article

"Small Sample Techniques," the research division of the National Education Association haspublished a formula for determining sample size. Regrettably a Table has not bee available forready, easy reference which could have been constructed using the following formula.

$s = X^2NP(1- P) \div d^2 (N -1) + X^2P(1- P)$.

s = required sample size.

X^2 = the Table value of chi-square for 1 degree of freedom at the desired confidence level

(3.841).

N = the population size.

P = the population proportion (assumed to be .50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

No calculations are needed to use Table 1. For example, one may wish to know the

sample size required to be representative of the opinions of 9000 high school teachers relative to merit pay increases. To obtain the required sample size enter Table 1 at N = 9000. The sample size representative of the teachers in this example is 368. Table 1 is applicable to any defined population.

The relationship between sample size and total population is illustrated in Figure 1. It should be noted that as the population increases the sample size increases at a diminishing rate and remains relatively constant at slightly more than 380 cases.

REFERENCE

Small-Sample Techniques.*The NEA Research Bulletin*, Vol. 38 (December, 1960), p. 99.

TABLE 1

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.

S is sample size.

APPENDIX J

Sampled validated instrument

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) Rabi Ganiyu
Head of Department: Signature, Date & Official Stamp

Head of Dept. Science Education
30 JUL 2019
Fed. Univ. of Tech. Minna

Student's Surname: KURE Other Names: Ishaft DANSUMA

Registration Number: PhD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: ALGEBRA ACHIEVEMENT TEST (AAT)

ATTESTATION SECTION

Summary of the Remark on the Instrument: The instrument is OK, however Some questions on linear equations should be change and some distractors need to be review. Add theory ques.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: Dr. ALIYU ALAAJI TAKARNYA

Designation: PRINCIPAL LECTURER

Name and Address of Institution: NIGER STATE COLLEGE OF ESUC, MINNA

Phone No: 08035539912 E-mail: nAaryamnam@gmail.com

AA. 23/11/2019
Signature, Date and Stamp

Sampled validated instrument

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) R. ... (Head of Dept. Science Education, Fed. University of Tech. Minna — 30 JUL 2019)

Head of Department (Signature, Date & Official Stamp)

Student's Surname: KURE Other Names: ... HANJUMA

Registration Number: PhD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: ATTITUDE TOWARDS ALGEBRA INVENTORY

ATTESTATION SECTION

Summary of the Remark on the Instrument: The instrument only focus on attitude of students towards learning Algebra as a subject. It does not measure how 5Es model and Reflective Discussion Instructional strategies will influence their attitude and achievement in Algebra.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: Ewemigi G. B.

Designation: Professor

Name and Address of Institution: IBB University Lapai – Counselling Psychology Dept.

Phone No: 08032953889 E-mail: ewemiyigeorge@gmail.com

4/11/2019

Signature, Date and Stamp

Please Turn Over

Sampled validated instrument

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) Rabi Garba
Head of Department: Signature, Date & Official Stamp

Head of Dept, Science Education
Fed. University of Technology
30 JUL 2019

Student's Surname: KURE Other Names: DANJUMA

Registration Number: PhD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: 5Es MODEL LESSON PLAN

ATTESTATION SECTION

Summary of the Remark on the Instrument: OK.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: Dr. ALIYU ALHAJI ZAKARIYA

Designation: PRINCIPAL

Name and Address of Institution: C.O.E, MINNA

Phone No: 08035539912 E-mail: nzayamma@gmail.com

23/11/19

Signature, Date and Stamp

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) R. I. Gimba
Head of Department (Signature, Date & Official Stamp

Head of Dept. Science Education
Fed. University of Technology Minna
30 JUL 2019

Student's Surname: KURE Other Names: ABDULSUMA

Registration Number: PHD/SSTE/2017/1020 Programme: PHD

Title of the Instrument: ATTITUDE TOWARDS ALGEBRA INVENTORY

ATTESTATION SECTION

Summary of the Remark on the Instrument

I hereby attest that the above named student brought his instrument for validation

Name of Attester: Dr John Jiya

Designation: Senior Lecturer

Name and Address of Institution: IBB University, Lapai

Phone No: 08035916588 E-mail: jiyakoyred@yahoo.com

30/7/2019
Signature, Date and Stamp

Please Turn Over

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertize to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of the form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) Rakiya Gambo
Head of Department (Signature, Date & Official Stamp

Head of Dept. Science Education
30 JUL 2019
Fed. Univ. of Tech. Minna

Student's Surname: KURE Other Names: SARAH ANUJUMA

Registration Number: PHD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: REFLECTIVE DISCUSSION STRATEGY LESSON PLAN

ATTESTATION SECTION

Summary of the Remark on the Instrument: OK.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: DR. ALIYU ALHAJI ZAKARIYYA

Designation: PRINC. LECT

Name and Address of Institution: C.O.E. MINNA

Phone No: 08035939912 E-mail: ndayammam@gmail.com

23/11/19
Signature, Date and Stamp

Sampled validated instrument

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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of this form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) R. A. Samson 30/7/19
Head of Department (Signature, Date & Official Stamp)

Head of Dept. Science Education
30 JUL 2019
Fed. University of Technology Minna

Student's Surname: KURE Other Names: BANUMA

Registration Number: PhD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: ATTITUDE TOWARDS ALGEBRA INVENTORY

ATTESTATION SECTION

Summary of the Remark on the Instrument: The instrument is within the context of targeted audience.

I hereby attest that the above named student brought his instrument for validation

Name of Attester: DR. [illegible]

Designation: SENIOR LECTURER

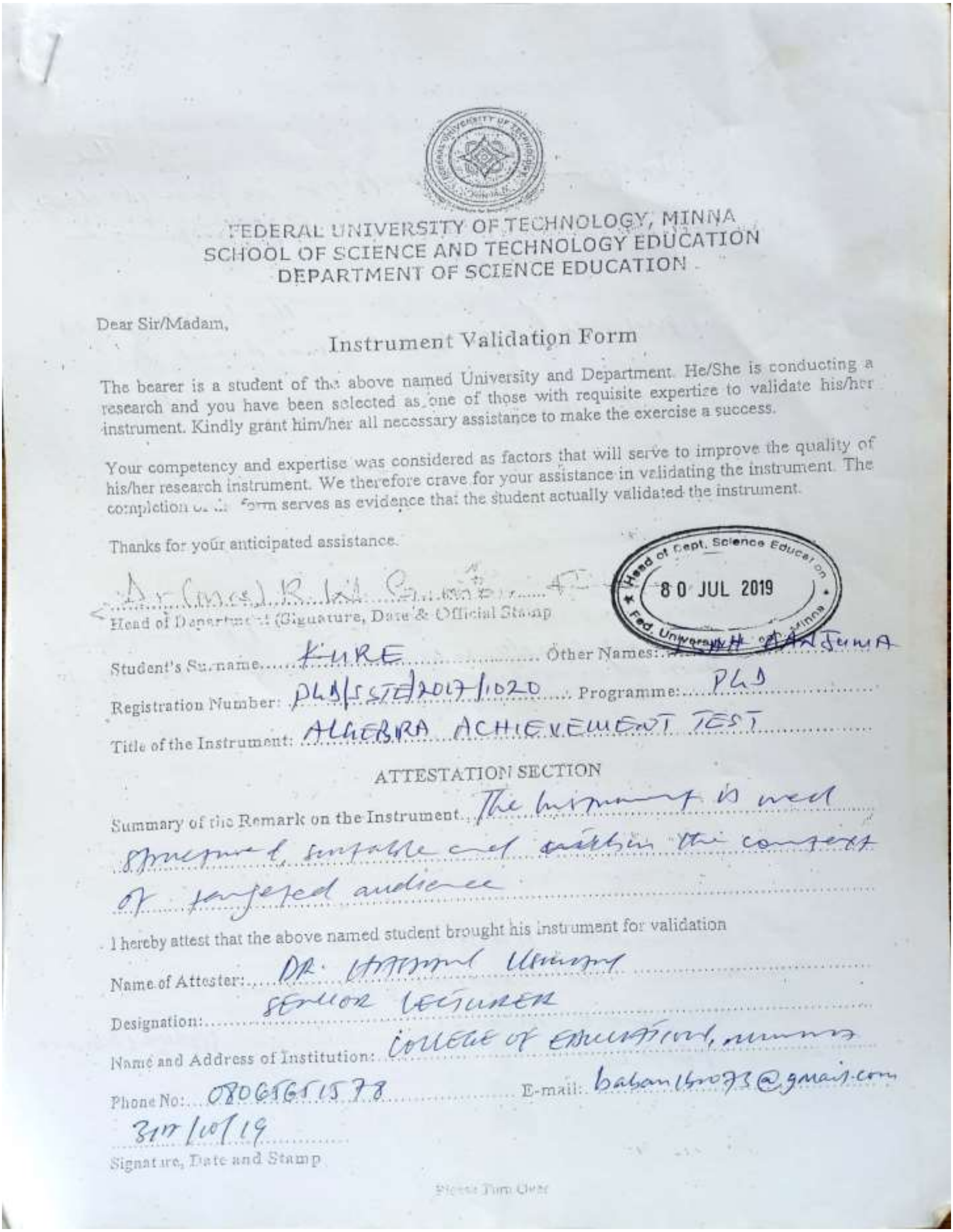
Name and Address of Institution: COLLEGE OF EDUCATION, MINNA

Phone No: 08065651578 E-mail: barbaraboy73@gmail.com

31/07/19
Signature, Date and Stamp

Please Turn Over

Sampled validated instrument



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

Dear Sir/Madam,

Instrument Validation Form

The bearer is a student of the above named University and Department. He/She is conducting a research and you have been selected as one of those with requisite expertise to validate his/her instrument. Kindly grant him/her all necessary assistance to make the exercise a success.

Your competency and expertise was considered as factors that will serve to improve the quality of his/her research instrument. We therefore crave for your assistance in validating the instrument. The completion of this form serves as evidence that the student actually validated the instrument.

Thanks for your anticipated assistance.

Dr (Mrs) R. W. Gimba
Head of Department (Signature, Date & Official Stamp)

Head of Dept. Science Education, Fed. University of Tech., Minna — 30 JUL 2019

Student's Surname: KURE Other Names: HANNAH JUMA

Registration Number: PhD/SSTE/2017/1020 Programme: PhD

Title of the Instrument: ALGEBRA ACHIEVEMENT TEST

ATTESTATION SECTION

Summary of the Remark on the Instrument: The instrument is well structured, suitable and within the context of targeted audience

I hereby attest that the above named student brought his instrument for validation

Name of Attester: DR. USMAN ...

Designation: SENIOR LECTURER

Name and Address of Institution: COLLEGE OF EDUCATION, MINNA

Phone No: 08065651578 E-mail: babanlono73@gmail.com

31/10/19

Signature, Date and Stamp

Please Turn Over