EFFECTS OF COMPUTER SIMULATION ON JUNIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND INTEREST IN ALGEBRA IN BOSSO LOCAL GOVERNMENT AREA OF NIGER STATE

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2017/3/69329BE

A PROJECT SUBMITTED TO THE
DEPARTMENT OF SCIENCE EDUCATION
SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

IN PARTIAL FULFILLMENT OF REQUIREMENT FOR THE AWARD OF BACHELORS OF TECHNOLOGY (B.TECH) DEGREE IN SCIENCE EDUCATION WITH OPTION IN MATHEMATICS EDUCATION FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

AUGUST, 2021

ABSTRACT

The study is an investigation into effects of computer simulation on junior secondary school students' achievement and interest in algebra in Bosso Local Government Area, Niger State A quasi-experimental, non-equivalent control group design was used in carrying out the research; the focus was on 540 JSS II students in Bosso Local Government Area, Minna Niger State as the population of the study. Fifty-four students, from two schools (male and female) sampled, were used as sample for the study. Intact classes were assigned by balloting to either experimental or control group and separately taught by their regular mathematics teachers who had earlier been trained for the purpose. All the groups were pre tested and post tested. Algebra Achievement Test (AAT) containing twenty multiple choice test and an Algebra Interest Inventory (AII) containing twenty items were used as instruments for both the control and the experimental groups. Four research questions and six hypotheses guided the study. Mean and standard deviation were used in answering the research questions while Analysis of Covariance (ANCOVA) was used in testing the hypotheses at $p<0.05$ level of significance. The results showed that the use of computer simulation approach in teaching affects students' achievement and interest in algebra. Also there was no significant interaction effect between the teaching method and gender on students' achievement and interest in Algebra. The study recommended among other things the incorporation of computer simulation approach in mathematics text books, organization of workshop and seminars for teachers on the use of computer simulation approach in the teaching and learning of mathematics especially in Algebra.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Mathematics is a very useful subject because it is applied in all fields of human endeavour. It is one of the most important subjects in education; hence it is a core subject in primary and secondary school levels in Nigeria (Usman, 2012). To many secondary school students, mathematics is a thorn on the flesh. But unfortunately for them, the opportunity of avoiding mathematics completely is not possible at both the primary and secondary school levels. This is because it is one of the compulsory subjects in school curriculum. Therefore, the relevance of mathematics cannot be over emphasized. According to Ronnie and Tim (2013):

> The study of mathematics can satisfy a wide range of interests and abilities. It trains in clear and logical thought. It is a challenge, with varieties of difficult ideas and unsolved problems, because it deals with the questions arising from complicated structures. Yet it also has a continuing drive to simplification, to finding the right concepts and methods to make difficult things easy, to explaining why a situation must be as it is. In so doing, it develops a range of language and insights, which may then be applied to make a crucial contribution to our understanding and appreciation of the world, and our ability to find and make our way in it.

The fact that mathematics is an important subject is not cajoled. Even a common man on the street will agree to this fact. Truly, Mathematics is an important and necessary subject for achievement in any part of the world. It is a subject that cannot be divorced from the world of technologists. However, any laudable achievement in technological development will be hampered if the potential Scientist, Engineers and technologists are not equipped with sound knowledge of mathematics (National Open University of Nigeria, 2006). Therefore, the growing importance of mathematics to Nigeria as a developing country cannot be toiled with. This could account why one of the objectives of secondary education under the

National Policy on Education (2004) is to equip the students with the skills to live effectively in a modern age of science and technology. The nation has therefore placed great emphasis on the study of mathematics and technology (Kolawole and Ilugbusi, 2017). Despite the considerable relevance of mathematics to human existence and despite the enviable position it occupies in the community of disciplines, students achievement in the subject at public examination have continued to worsen year after year (Kolawole and Ilugbusi, 2017).

Poor achievement in mathematics in Nigerian secondary schools has assumed alarming proportions and caused a lot of concern for many years (Aburime, 2009). Over the years, mathematics educators have identified various causes of difficulties in learning mathematics. According to Kurummeh and Achor (2008), the difficulties of students in learning mathematics could be attributed to the approach to which the contents are being presented to the students, the abstractness of mathematical concepts, and poor foundation, among others. Korau (2016) opines several variables ranging from the teaching methods, learners themselves, the teachers, textbooks, the curricula, school environment to be responsible for students' poor achievement in mathematics. Kolawole and Ilugbusi (2017), observed that the alarming rate of students' underachievement in mathematics at all examinations and at all levels may be due to a number of factors such as; lack of enough qualified and experienced mathematics teachers, location of school, sex of teacher, type and nature of public examination items and the difficulties with teachers experienced in teaching most of the mathematics topics. However, the poor performance in mathematics according to Betiku (2012) is due to the methods of teaching, attitude of the teachers that teach the subject and students lack of interest in the subject.

Interest is an important variable in learning because when one is interested in an activity, one is likely to perform perfectly well. Interest can be expressed through simple statement made by individual about their likes and dislikes. Obodo (2014), described interest as the attraction, which forces or compels a child to respond to a particular stimulus. By implication, a child develops interest if a particular stimulus is attractive and arousing or stimulating to him/her. In other words, the child is bound to pay attention as lesson goes on if interest is shown. This shows that interest comes as a result of eagerness to learn not by force (Harbor-Peters, 2012).

Similarly, Adeleke (2011), observed that the rate of students' poor achievement is alarming and equally disturbing and it is most likely that most students have some mathematical knowledge but they may have almost no understanding of the basic structure of mathematics, thereby making them to resort to memorization of mathematical facts and concepts. Adeleke further stressed that one particular area which students' problems have been documented is algebra. Perhaps, this is so because historically, algebra has represented students' first sustained exposure to the abstraction and symbolism that makes mathematics powerful (Kieran, 2012). It then becomes the duty of the teacher to teach mathematics in a way to encourage the understanding of the required basic structure of mathematics. One way of achieving this is through a careful and thoughtful selection of appropriate teaching strategy that will help students in understanding mathematical concepts, especially in algebra rather than passive reception of ideas.

However, many teachers adopt the conventional approach to teaching. This is an approach where older methods or ideas are followed rather than modern or different ones. In this approach, curricular activities rely heavily on textbooks and workbooks not on creative and innovative approach.

Furthermore, in conventional setting, many students struggle to understand concepts in mathematics as they end up cramming principles just to pass examinations. To some students, success in school has very little to do with true understanding and much to do with coverage of the curriculum. In many schools, the curriculum is held as absolute and teachers are reticent about it even when students do not understand important concepts. Rather than adapting the curriculum to students' need, the predominant instructional response in a conventional setting is to view those who have difficulty in understanding the unaltered curriculum as slow learners (Ogbonna, 2013).

As technology advances, there are suggestions that technology could be used as a tool to minimize difficulties that students incur in mathematics classrooms. The National Council for Teachers of Mathematics (NCTM) (2003) advocated that:

> Every school mathematics program should provide students and teachers with access to tools of instructional technology, including appropriate calculators, computers with mathematical software, internet connectivity, handheld data collection devices, and sensing probes … They [technology tools] also enhance computational power and provide convenient, accurate, and dynamic drawing, graphing, and computational tools. With such devices, students can extend the range and quality of their mathematical investigations and encounter mathematical ideas in more realistic settings.

The NCTM's call for the use of technology in the classroom is based on the assumption that technology will help improve the learning of mathematical skills without compromising computational skills that students need to acquire. Other organizations also have joined the call for the inclusion of technology in mathematics classrooms and this call is vibrant in the corridors of institutions that provide training for mathematics instructors. A technical committee for the Association for Mathematics Teachers Education (AMTE) recommended that teacher training programs need to focus on preparing pre-service teachers to incorporate technology in their classrooms to facilitate students' learning (AMTE, 2005).

It has been declared by Tokpah (2017) that computers could be used in the classrooms to improve students' acquisition of basic skills in specific subject areas, reduce the drudgery of learning by blending text with multimedia, broaden curriculum objective through the use of stimulations to aid in problem-based and collaborative learning, enable teachers to strengthen their mode of content delivery, and prepare technology literate citizens for the workplace (Abdullah, 2005; Pierce & Stacey, 2004; Adym, 2005; Heid & Edwards, 2001; Kutzler, 2000; Norton et al. 2000).

It has been identified by Usman (2002) that computers can be used in three ways; as a tool, a tutor and a tutee. Taylor (2010) in Twing (2012) also affirms that there are three ways computers are used in educational setting: as a tutor, a tutee and a tool. When used as a tutor, the computer adapts to the student by selecting appropriate instructional resources and maintaining record of academic progress. As a tutee, the computer receives and executes instructions (in the form of programming language) from the student. As a tool, the computer is used to aid in calculations and graphical displays.

Research has shown that traditional instruction does little to change students' "commonsense" beliefs (Tambade and Wagh, 2015). However, it has been demonstrated that if this situation is taken into account, it is often possible to provide activities that induces most of the students to develop a good functional understanding of many of the basic concepts through interactive engagement methods.

Among the several factors pointed out by Kurummeh et al, as causes of students' poor achievement in mathematics, they seemed to anchor on the teaching method as a major factor hindering mathematics achievement. However, many instructional strategies have been proposed, such as learning by doing, guided inquiry, problem solving and so on. In Nigeria emphasis is placed on the use of guided discovery instructional strategy (FME, 1995). This instructional strategy is activity oriented and involves practical demonstration. Students are guided by materials and leading questions from the teacher to discover mathematical concepts. Yet over the years, the result of this instructional strategy planned towards improving the quality of instruction in mathematics has been disappointing and seems ineffective. Current studies on how students learn science and science related subjects (mathematics) have proved effective. One of such innovative instructional strategies is the computer simulation approach (Akpan, 2002; Lunce, 2006; Tambade & Wagh, 2015).

Computer simulation (or "sim") according to Wikipedia (2009), is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. Computer simulation as described by Thomas and Hooper (2011) is a computer program containing a structural model of a real or theoretical system. The program enables the students to change the model from a given state to a specified goal state by directing it through a number of intermediate states. Thus, the simulation program accepts commands from the user, alters the state of the model, and when appropriate displays the new state.

According to Ton and Wouter (2016), common characteristics of educational computer simulations are:

1. Model Based: Simulations are based on a model. This means that the calculations and rules operating the simulation are programmed. These calculations and rules are collectively

called "the model", and it determines the behavior of the simulation depending on user actions.

2. Interactive: Learners work interactively with a simulation's model to input information and then observe how the variables in the simulation change, based on this output.
3. Interface driven: The value changes to the influenced variables and the observed value changes in the output are found in the simulation's interface.
4. Scaffolded: Simulations designed for education should have supports or scaffolds to assist students in making the learning experience effective. Step by step directions, or small assignments which break the task down to help students, while they work with a simulation, are examples.

There are three (3) ways to use computer for simulation activities as stated by Robert (2010)

1. Run a simulation programme on the computer – which is the major focus of this study.
2. Use simulation on the World Wide Web.
3. Enhance simulation with computer i.e. one can display images and pictures on the computer screen to add reality to many simulations. (Robert, 2010).

According to Lunce (2016) the purpose of simulation is to motivate the learner to engage in problem solving. Lunce also stress that simulation is based on an internal model of a real-world system or phenomena in which some elements have been simplified or omitted in order to facilitate learning. Computer simulations can be used in the classroom to help students to gain additional insight into the phenomena. Computer simulations are also useful for providing more extended practice in thinking about a wide variety of examples (Tambade & Wagh, 2015).

Simulations have a number of advantages over other instructional methodologies. Students often find active participation in simulations to be more interesting, intrinsically motivating and closer to real world experiences than other learning modalities (Alessi & Trollip, 2011). Simulations have been shown to provide transfer of learning with the result that what is learned facilitates improved performance in real-world settings (Leemkuil, et. al., 2013). Further, there is evidence to suggest that simulations may be more efficient modalities for learning in some content areas (Alessi & Trollip, 2011). Simulations can be very flexible in that both student and instructor can have a high degree of control over simulation variables (Duffy & Cunningham, 2016; Hung & Chen, 2012). Simulations can accommodate a wide range of instructional strategies, including microworlds, scientific discovery learning, virtual reality, laboratory simulations, role playing, case-based scenarios, and simulation gaming (Alessi & Trollip, 2011). Through simulations the learner is given the opportunity to practice on his or her own with a variety of situations which resemble "real-life" problems which they might face in the future. And it is this type of practice, which they indicate enhances the learner's problem solving skills (Akpan, 2011). Simulations are creative; students are organized into small groups, goals are set for individuals, as well as for the groups with which they work. The goal setting in conjunction with the competition with the other groups keep the students very involved in the learning (ITC, 2007).

Computer simulations do have distinct disadvantages compared with other modalities. First, because computer simulations are often used with “problem-based learning” methods, they stimulate learners to immerse themselves in a problematic situation and experiment with different approaches (Heinich, et. al., 2015). This type of learning may require significantly more time than other methods of instruction. Second, research has shown that, without coaching, the learner gains little from "discovery learning" from computer simulations (Min, 2001; Heinich, et. al., 2015). Third, constructivists argue that computer simulations "oversimplify the complexities of real-life situations", giving the learner a "false understanding" of a real life problem or system (Heinich, et. al., 2015). Finally, development of computer simulations may involve extensive planning and require significant investment of labor and financial resources.

Despite the significant results recorded in other subjects and the advantages derived from computer simulation as outlined above, evidence shows that not much has been done in the use of computer simulation as a teaching strategy in mathematics education and specifically in algebra.

Modern psychological studies have shown that gender as a variable relates to performance (Ezeugo and Agwagah, 2010). For instance, Olaguaju, (2011) observed that boys choose science courses in high schools than girls especially mathematics, chemistry and physics. This is due to the long held view that women are weaker vessels who cannot stand the stress and strain involved in problem solving. To this end, Ugwu (2012) argued that at present, females are struggling to fight the oppression, suppression and domination by their male counter parts. This was supported by Azuka (2010), who stated that significant difference in the performance of male and females on geometric proofs does not exist. Agwagah (2015) found out that female students performed significantly higher than their male counterparts in mathematics readings. Thus, there is also the need for further investigation on whether male and female students would respond differently on Algebra when computer simulation is used.

1.2 Statement of the problem

Over the years, the performances of students in mathematics in Nigeria schools have been very poor. The concern about performance of students in mathematics has led to several suggestions for improvement. Unfortunately, these suggestions revolve around the inappropriate teaching methods as the major cause of students' poor performance in mathematics. Hence, mathematics researchers are in search of innovative teaching methods and strategies that will enhance achievement in mathematics.

Although some researchers such as Akpan (2012) and Lunce, (2016) have advocated the use of innovative strategies such as the computer simulation approach which incorporates inquiry and cooperative learning in teaching science and science related subjects (mathematics), no studies to the best of the researcher's knowledge have investigated the effects of computer simulation in teaching junior secondary school class mathematics content (Algebra). Based on the foregoing, the major issue of academic concern for this study posed as a question is; what are the Effects of computer simulation on junior secondary school students' achievement and interest in algebra?

1.3 Aim and Objectives of the Study

The major purpose of this study is to investigate the effects of computer simulation on junior secondary school students' achievement and interest in algebra in selected algebraic concepts. Specifically the study seeks to;

i. Determine the effect of computer simulation on students' achievement scores in algebra.

ii. Determine the effect of computer simulation on the mean achievement scores of male and female students

iii. Determine the effect of computer simulation on students' interest scores in algebra.

iv. Determine the effect of computer simulation on the mean interest scores of male and female students.

1.4 Research Questions

The following research question guided this study

i. What is the mean achievement scores of students taught with computer simulation and those taught with conventional approach in the Algebra Achievement Test (AAT)?

ii. What are the mean achievement scores of male and female students taught using computer simulation in the Algebra Achievement Test (AAT)?

iii. What is the mean interest scores of students taught with computer simulation and those taught with conventional approach in the Algebra Interest Inventory (AII)?

iv. What are the mean interest scores of male and female students taught using the computer simulation in the Algebra Interest Inventory (AII)?

1.5 Research Hypotheses

The following hypotheses were tested at the 0.05 level of significance:

i. There is no significant difference between the mean achievement scores of students taught with computer simulation and those taught with traditional method, as measured by the Algebra Achievement Test (AAT).

ii. There is no significant difference between the mean achievement scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Achievement Test (AAT)

iii. There is no significant difference between the mean interest scores of students taught with computer simulation and those taught with traditional method, as measured by the Algebra Interest Inventory (AII).

iv. There is no significant difference between the mean interest scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Interest Inventory (AII).

v. There is no significant interaction effect between method and gender on the students' achievement in Algebra.

vi. There is no significant interaction effect between method and gender on the students' interest in Algebra.

1.6 Scope and Limitation of the Study

This study was carried out with JSSII students in Bosso Local Government Area, Minna, Niger State. The content scope includes topics on Solving Equations (Simple Linear Equation) such as Equations by the balance method, Equations with brackets and Equations with fraction. The computer simulation approach and the conventional method were used to investigate whether they have any effect on students' achievement and interest in Algebra.

1.7 Significance of the Study

Research evidence has shown that there is poor achievement among secondary school students in mathematics. It has also been revealed that poor teaching method, students' lack of interest, home background, among others are some of the factors which influence students' achievement in mathematics. However, the computer simulation approach introduced by Tambade & Wagh in physics teaching has been found to be a viable educational medium which can help teachers become more effective, it can serve as a tool for curriculum development and promote meaningful learning. Therefore, the result of this study will provide information on how Nigeria students will perform when taught using computer simulation.

The result of this study therefore can be of great benefit to the following:

i. Students
ii. Teachers of mathematics
iii. Educational administrators
iv. Higher institutions

The result of this study will be of immense benefit to students as it would make them see algebra as a simplified subject. It will also be a means of fostering creativity and cooperativeness between students and teachers.

The result of this study will also be of great benefit to the teachers of mathematics because it will supply information that would enable him to make the right choice of teaching method when teaching algebra. It will also provide the teacher with information on a good evaluation technique for mathematics instruction.

Again, to the educational administrators, the findings of this study can provide information with which they can organize conferences, workshops and training programmes for teachers so as to communicate to teachers the alternative models to the teaching of mathematics for maximum comprehension. It can also guide them in the provision of necessary materials for effective learning and in restructuring the curriculum to include new innovations.

Finally, the result from this study can also provide more information for teacher training and tertiary institutions such as colleges of education and faculties of education of Nigeria universities.

1.8 Operational Definition of Terms

Computer Simulation: is the process of mathematical modeling, performed on a computer which is designed to predict the behavior or the outcome of a real world or physical system.

Achievement: is the act of achieving something or a thing done successfully, typically by effort, courage or skill.

Interest: is a feeling of wanting to learn more about something.

Algebra: is the study of mathematical symbols and the rules for manipulating these symbols.

CHAPTER TWO

LITERATURE REVIEW

The relevant literatures related to this study were reviewed under the following subheadings:

Conceptual Frame Work

Computer Simulation

Nature of Simulation

Interest as a factor in academic achievement

Theoretical Framework

Bruner theory of learning

Related Empirical Studies

Studies on computer simulation

Studies on gender as a factor in mathematics achievement

Studies on Interest as a factor in academic achievement

Summary of Literature Review

2.1 Conceptual Frame Work

2.1.1 Computer simulation

A computer simulation according to Wikipedia (2009) is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables, predictions may be made about behaviour of the system. It could also be seen as a computer programme that attempts to simulate an abstract model of the particular system. Computer simulation as described by Thomas and Hooper (2011) is a computer program containing a manipulated model of a real or theoretical system. The program enables the students to change the model from a given state to a specified goal state by directing it through a number of intermediate states. Thus, the simulation program accepts commands from the user, alters the state of the model, and when appropriate, displays the new state. Computer simulations can be powerful tools for analyzing, designing, and interacting with complex systems or processes. Well-designed computer simulations provide a model of those elements most relevant to the immediate learning objective. In addition, "they inform the instructor and the learner of aspects of the real-life system or process that have been simplified" or eliminated (Heinich, Molenda, Russell, & Smaldino, 2014; Sternberg, 2014). Effective computer simulations are built upon "mathematical models" in order to accurately depict the phenomena or process to be studied (Min, 2002). At the same time, "computer simulations have been found to be most effective for learning when unimportant aspects of the real-life situation or process are eliminated from the simulation" (Granland, Bergland, & Eriksson, 2010).

According to Akpan (2002) science describes simulation as "the process of designing a model of a real system and conducting experiments with this model for the purpose either of understanding the behavior of the system or evaluating various strategies for the operation of the system. Simulations may prove to be a valuable medium through which educators can tap the power of the computer to help learners develop higher level cognitive processes and problem solving skills (Ellis, 1984; Marks, 1982; Nakleh, 1983, and Switzer and White, 1984). A number of authors have argued that, in science courses, classroom simulations potentially have an important and valid role in creating virtual experiments that allow students to use instruments and monitor experiments, test new models, and improve their intuitive understanding of complex phenomena. Heinich et al (2015) indicate that simulations can help students to identify relations between components of a system to learn about the system and to control them. Through simulations the learner is given the opportunity to practice with a variety of situations which resemble "real-life" problems which they might face in the future. Simulations encourage the skill of synthesis by applying what the student already knows to a unique situation and thus, strive for a higher level of cognitive functioning by providing the student with a variety of responses. Simulations can also provide students with learning environments in which students search for meaning, appreciate uncertainty, and acquire responsibility.

The use of simulations in science education can make significant contributions by providing appropriate learning opportunities to diverse learners and motivating students to learn science, both inside and outside of the school environment. Simulations present students with problems and allow students to utilize the simulation as a powerful tool to carry out investigations and to solve problems. Educational simulations are designed both to teach content and to enhance higher-order problem-solving skills. Simulations allow learners to explore and manipulate variables and then obtain results from the various manipulations. Those results should provide feedback to their thinking and learning processes.

Computer simulations provide a method for checking our understanding of the real world by modeling the structure and dynamics of a conceptual system or a real environment (Lunce, 2014). They facilitate “interactive practice” of real-world skills by focusing on essential elements of a real problem or system (Heinich, Molenda, Russell, & Smaldino, 1999). Computer simulations can “communicate complex and technical scientific information” similar to interactive museum exhibits (Saul, 2011). A well-designed computer simulation can engage the learner in interaction by helping the learner to predict the course and results of certain actions, understand why observed events occur, explore the effects of modifying preliminary conclusions, evaluate ideas, gain insight and stimulate critical thinking. Computer simulations can also provide the learner with "feedback throughout the learning process" (Granland, Bergland, & Eriksson, 2010). Because "computer simulations are flexible and dynamic", they can guide the learner in the achievement of specific learning goals (Gibbons, Fairweather, Anderson, & Merrill, 2012).

Computer simulations do have a number of disadvantages when compared with other instructional methodologies. First, since computer simulations are often used with "problem-based learning" methods, they stimulate learners to involve themselves in a problematic situation and thereby experimenting with different approaches which takes a long time to arrive at the result (Heinich, et. al., 2015). Therefore, this type of learning may require significantly more time than other methods of instruction. Second, research has shown that, without coaching, the learner gains little from "discovery learning" from computer simulations (Min, 2001; Heinich, Molenda, Russell, & Smaldino, 2015). Third, constructivists argue that computer simulations "oversimplify the complexities of real-life situations", giving the learner a "false understanding" of a real life problem or system (Heinich, et. al., 2015). Finally, development of computer simulations may involve extensive planning and require significant investment of labor and financial resources.

2.1.2 Nature of Simulation

According to Rik (2011), Simulation is a real container concept: it is multi-explicable and is found in education in many forms as a method of learning, role plays, group discussions, management games, war games, training simulators, model driven simulation etc.

In his work he considered simulation from a perspective of trying to learn by oneself and to see the simulation programme as a learning tool. He restricted him self to computer-based simulations in his work. Therefore this work is restricted to the more or less ordinary, 'model-driven computer simulation': computer simulation based on mathematical models of phenomena that we consider essential to import into education - via the computers - in a lesson or to pass it on to a child as a worthwhile experience.

Ordinary model-driven computer simulation can be used as a learning tool. It brings phenomena from the world of children and grown ups into the home. Suddenly one has 'something' available that shows the growth of crops in the tropics, or information about the Dutch economy or in the field of medicine at a low price and with little trouble. Teachers and educational planners love to use such learning tools in education, at school, for in-company trainings or extra mural training in general at institutions such as the Open University, Dutch Training College Leyden (LOI) or at home, on CD-i, CD-rom, or downloaded from the electronic highway. In general, computer simulations are valuable multimedia products. Now, graphics, animations, movement, video and other dynamic forms of representation have become affordable and so they can play a major part. Such simulations can not run without mathematical models (i.e. 'model-driven') to describe the relative phenomena or, if knowledge-based, to give intelligent feedback. Apart from the fact that simulations that should be based on mathematical models do not function without a computer, it is indispensable for its part in digitising all kinds of information and feedback.

As put forward by Rik (2011), if you want to make optimal use of expensive, powerful environments that are rich in feedback, you can apply model-driven simulations of phenomena in many ways, viz.:

a) to demonstrate or explain something (in front of the class);

b) to make it possible for a student to practice (individually or in pairs):

    i. with assignments (let them do something)

    ii. with cases (problem solving)

    iii. with proper instructions;

c) to test a student;

d) to help understand theoretical problems or at least **being able to visualise them;

e) to examine a student and 'measure' if he has understood something of the theory and whether he can apply it in practice.

Imitations of 'reality' or simulations of phenomena ('model-driven simulation') can be used to explain something in class, but also to be able to test someone on insight or skill. Simulations can not merely be used functionally, but also for individual learning. Someone can learn something on his own through discovery or well coached in a beautiful environment rich in feedback. The educational method of application is called 'methods of learning' or 'learning models'.

Coaching or a method of learning is necessary in every open environment, but also in an open work environment and in virtual realities (VR). The learner has to offer the user something, 'an instruction', even if it is only a hint. Simulations based on mathematical models - both those on the Web and on cd-rom - can be applied in six different ways. In his approach there are six different methods of learning; also called 'learning models'. Every learning model has its particular pros and cons. This is how Rik define 'learning models' in his work: 'Learning models are acting patterns of students, who use a computer simulation programme in a certain way which was previously determined by the designer'. The aim is to record the general patterns of an average student in such a learning situation, and not individual behaviour. Both simulation designer and teacher using simulation should be aware of objective behaviour caused by it. Apart from student characteristics, every method of learning has its particular, specific, objective (dynamic) characteristics. Dynamic behaviour of learning models is characterised most by the different methods of instruction. They are often parallel or sometimes ordinary instruction, given beforehand or computer-based, - adaptive - instruction in clever doses. (as in 'ITS or 'ICS'). In one of the learning models there is no instruction whatsoever. Rik distinguished six different methods of learning viz.:

1. Free, discovery learning;
2. Learning by doing assignments;
3. Guided or coached learning:
   i. with a help-system (passive or intelligent)
   ii. with a complete instruction programme (sequential of parallel)
   iii. with a more or less intelligent system for generating test questions
   iv. with an 'intelligent tutor' (ITS systems)
4. Problem oriented learning; based on a problem or case;
5. Learning by carrying out 'real' scientific experiments;
6. Learning with 'intelligent' computer simulation models (ICS programmes).

Of the six methods distinguished, Rik only discuss the first five. Most methods have different variations which are not discussed in detail. With the third method, he mentioned the different approaches because they cause essential differences in the way of learning. Min calls these methods of learning 'qualitative learning models'. These methods were discussed one by one as follows:

Free discovery learning: With the first method of learning, 'free discovery learning' (1), the intention is to allow the student to work on his/her own. He can do things he likes and which he believes are useful. He can interrupt in a model or in a micro world and try to discover relations between actors and variables. One student will do something to teach himself a certain skill, the other to create a certain game effect. In general, a learner will soon be bored with a computer simulation programme using this method. It is usually a system with certain simplicity. In order to make proper use of simulations, background knowledge is needed and a plan of approach. Free discovery learning - with little or no instruction - should not be recommended. Someone who simply tries something out and doesn't know things - or cannot - will never make the most of a simulation. Consequently, many users of simulations - also teachers checking if a simulation model is suitable for their students - will, at an early stage, be disappointed in certain programmes.

For it is essential to accept a certain coaching or instruction. This will guarantee the teacher that all possibilities of the programme will actually appear. Reality, even when simulated, is so complicated that a user without preparation or coaching will not see or discover anything worth learning. A user should have good domain knowledge. That is why the method of 'free discovery learning' is never used on its own in practice. Coaching is always present in a realistic learning environment. Either in the form of an assignment, a case, an instruction programme or an oral task given by a teacher.

Learning with the help of assignments: The second method of learning, ' learning by doing assignments' (2) is often applied, in particular to discover simulations. The learner is asked to carry out assignments and see what happens. Before he begins with the assignment he is asked to write down what he thinks is going to happen. Thus, the learner learns to formulate a hypothesis before he has done anything. That hypothesis is then tested immediately in a simulated reality. The tasks in this method of learning can be simple at first, with an increasing complexity. At the same time certain technical actions, such as operating a scroll bar, are learned almost automatically. The student learns to operate a computer simulation programme and see all its possibilities within a certain amount of time. The student doesn't have to solve problems on his own with this method or have to understand the model completely.

In general the assignments are supplied in writing (parallel to the PC) or digitally (usually also parallel). These assignments maybe a couple of loose worksheets or bundled together in a workbook. Worksheets or workbook have been designed in such a way that there is ample space for notes and questions. Questions and answers can be taken home at the end of a session or given to the teacher, for his assessment.

Coached learning: The third method of learning, 'coached or guided learning' (3) requires a differently designed simulation environment than learning environments where you merely learn to do an assignment by your self. The computer simulation programmes themselves may look identical, but the learning environment should contain all kinds of extras. Those extras are essential for the functioning of the computer simulation programme: completely different. Rik in his work distinguish four kinds of 'coaching' or 'guidance'. These four kinds of coaching - either combined or separate - are:

a) A help system with relatively passive, extra information which can be supplied when the learner asks for it.

b) A complete piece of tutorial course ware or a simple piece of instruction used as coach. This can be done in two different ways: one embedded in the instruction, and the other by 'running' the instruction beside the simulation on a 'multi-tasking' operating system;

c) A more or less intelligent system for generating test questions. A little known coaching method that can be particularly useful for simulations with lots of dialogue. Such systems give the students feedback by setting them certain test questions at specific moments. This depends on 'the individual passing through the simulation'. See for instance the anamnesis training programme of Min and Ephraim. This simulation programme generates multiple choice questions on the screen, on unpredictable moments, depending on how the learner passed through the programme (Min and Ephraim, 2010);

d) An 'intelligent tutor'. Simulations which can be supplied with an 'ITS system' ('intelligent tutoring system') and can be used are still being developed. An 'intelligent tutor' has so far not been properly realised and tested anywhere. A really intelligent tutor is hard to realise. The present systems which have been described in literature - usually made with Prolog or Lisp - rarely achieve the level that could be achieved with simple, tutorial COO.

The intelligent tutoring systems' (ITS) should not be confused with 'intelligent computer simulations' (ICS). Intelligent computer simulation programmes (ICS-programmes) are according to Min's (2010) definition computer simulations which have an expert system for a basis instead of a mathematical model (Min, 2010). Such an ICS-programme can contain one or more mathematical models or an intelligent tutor as well. Combinations of learning models are very common in practice.

Learning based on cases: The fourth method of learning is 'problem oriented learning' (4). Here we work with written materials in which a 'case' is described in detail. Learners should follow such a 'case' step by step. The case is recorded - in the computer simulation programme itself - in the model, as interruption in one or two parameters. The phenomenon that belongs to the case is shown on the screen, but not the instruction. This can be found on some loose or bundled worksheets in a workbook. The phenomena on the screen are presented dynamically. They are determined by the setup of the underlying model as intended by the designer of the programme or the teacher. While 'running' the case certain variables do something 'abnormal' or something 'characteristic'. The first step of the learner when solving the case, is to analyse the phenomena. The conclusion of the analyses will be the hypothesis. Next that hypothesis has to be tested. Testing is done by changing one or more parameters in such a way that the model behaves 'normally' again. Then that parameter setup can be seen as the cause for the 'abnormality'. However, the phenomenon can also be compensated instead of being solved. Then we call it 'treatment of symptoms'. This is the case if, after an intervention in the model, a 'normal', seemingly healthy situation occurs. In this method of learning with a case we see the following steps: 'analysing the phenomenon' (the problem), 'making diagnoses', and 'solving the problem' or 'taking (therapeutic) action'. This way of learning is more interesting than discovery learning. Variations in didactic methods can be very effective.

Learning by scientific experimenting: Finally the fifth method of learning: 'learning by doing real - scientific - experiments with the simulation programme' (5). This is a method that resembles practicals in higher vocational or university education during which something has to be measured in order to reach a certain insight. For instance a variable (temperature) is measured and a certain parameter gets a series of values, 0.1, 0.2, 0.5 and 1.0. Such a (scientific) experiment can be easily done with a computer simulation programme. It is fast and can be repeated again and again. The relative numerical values of variables in relation to that model parameter can be determined with the computer simulation programme. Then they are written down on a paper worksheet or electronically on a so called 'scratch pad'. A scratch pad could be an input field on a web page. After the experiment the data can be put in graphics, for instance on graph paper, just like in a real practical. The learner will see certain connections through these actions together and in particular by studying changes in the graphics.

2.1.3 Interest as a factor in academic achievement

The Webster encyclopedia dictionary of English Language conceptualized interest as the feeling of one whose attention, concern or curiosity is particularly engaged by something. To create and sustain interest becomes one of the most important tasks of mathematics teachers at all levels of education.

Interest is a tendency to become absorbed in an experience and continue it, (Herbor-Peter, 2012). It is the zeal to participate in an activity from which one derives some pleasure. Interest is an important variable in learning because when one is interested in an activity, one is likely to achieve highly in that activity. Studies on interest are concerned with identifying different approaches in teaching that may be used to generate and sustain students’ interest for higher achievement. Interest has been defined by different authors in various ways. Obodo (2012) described interest as the attraction which forces or compels a child to respond to a particular stimulus. This pointed out the facts that a child develops interest if a particular stimulus is attractive, arousing or stimulating. This is to say that he or she is bound to pay attention as a lesson goes on if he is interested in that particular lesson. This reveals that interest comes as a result of eagerness or curiosity to learn not by force.

Taylor (2010) opined that interest enabled individual to make a variety of choices with respect to the activities in which he engages. This means that if a student has positive interest toward a particular subject he will not only enjoy studying it but will also derive satisfaction from the knowledge of the subject.

Interest has been viewed as emotionally oriented behavioural trail which determine a students' vim and vigour in tacking education programmes or other activities Ezewu and Okoye (2011). Without interest students incline to surface level learning (Entwistle 2000; Chin and Brown 2010). With interest they are maybe likely to engage in deep level learning. The purposes of stimulating the student's interest according to Jingsong (2013) are: attract students; keep students active; increase students' enthusiasm for the course; and very importantly, if their study is interesting, and not always boring, then the student will be keen to study, and will be happy to study. Therefore the main question is how to stimulate and cultivate the interest of students in mathematics especially in algebra when computer simulations are used.

2.2 Theoretical Frame Work

The theoretical framework of this study is on Bruner theory of learning and how it affects the computer simulation approach.

2.2.1 Bruner Theory of Learning

Jerome Bruner worked on the process of thought in general. Later he applied this to the process of learning mathematics (NOUN, 2006). In 1966, Bruner wrote *Toward a theory of instruction*, in which he explained how his ideas might be translated into practice in the classroom. A further factor which contributed to the popularity of Bruner's ideas was that they were very much in tune with the mood of the times. His emphasis on discovery and 'hands on' learning was in accord with Piaget's ideas. Certainly the constructivist nature of his theory appealed to teachers and many of his principles are still employed by practising teachers. Bruner argued that teachers should teach the 'structure' of subjects. He advocated the introduction of the real process of a particular discipline to students.

The three stages in Bruner's theory of intellectual development are:

a) *Enactive* where a person learns about the world through actions on objects.

b) *Iconic* where learning occurs through using models and pictures.

c) *Symbolic* which describes the capacity to think in abstract terms.

Bruner's underlying principle for teaching and learning is that a combination of concrete, pictorial then symbolic activities will lead to more effective learning. The progression is: start with a concrete experience then move to pictures and finally use symbolic representation.

2.2.2 Bruner's Constructivist Theory

A) Description

Bruner's constructivist theory is based upon the study of cognition. A major theme in this theory is that "learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge" (Kearsely 1994b). Cognitive structures are used to provide meaning and organization to experiences and allow the individual to go beyond the information given.

According to Bruner, the instructor should try and encourage students to construct hypotheses, makes decisions, and discover principles by themselves (Kearsley 1994b). The instructor's task is to "translate information to be learned into a format appropriate to the learner's current state of understanding" and organize it in a spiral manner "so that the student continually builds upon what they have already learned."

Bruner (1966), as cited in Kearsley (1994b) states that a theory of instruction should address the following aspects:

a) the most effective sequences in which to present material

b) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner.

B) Practical Application

Bruner’s constructivist theory can be applied to instruction, as Kearsley (1994b) surmises, by applying the following principles:

a) Instruction must be concerned with the experiences and contexts that make the student willing and able to learn (readiness).

b) Instruction must be structured so that it can be easily grasped by the student (spiral organization).

c) Instruction should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given).

The theory of Bruner can be applied in the teaching and learning of mathematics since it involves discovery, readiness, intuition and analytical language. Thus, this theory encourages the learner to be inquisitive, explorative, initiative, innovative and to engage in self discovery in the process of learning. The computer simulation approach is designed in such a way that they ensure continuity of understanding and that all the above qualities are attained by the learner.

2.3 Empirical Studies

2.3.1 Studies on Computer Simulation

Computer Simulation has been adopted by several researchers who have employed it at all levels in different disciplines such as physics, biology, etc.

Tambade and Wagh (2015) carried out a study to examine the effectiveness of computer simulations in traditional classroom teaching of physics to enhance students' conceptual understanding. The topic of Oscillations in physics of second year degree syllabus was taken for the study. The main goal of the study was to investigate students' difficulties in understanding of oscillations and design new instructional methods to address these difficulties. The investigators limited the study for second year undergraduate students within the Pune University of Maharashtra State, India. The pretest was administered to 128 students during the second semester of academic year 2005-2006 and 2006-2007 to identify students' difficulties. After analyzing students' performance in pretest, they were placed in two groups viz. experimental group and control group each of 64 students by random selection. A t-test was administered to find out the significance of the difference between the mean scores of the experimental and the control groups at the pretest and posttest. At the end of experiment, experimental group students are better placed in interpretation of formula, graphical representations and interpretation of physics in given situations as compared to the control group students. They are also more consistent about conceptual understanding as compared to control group students. The overall results indicate that students seem to have acquired a good general understanding of these concepts using such simulations. Hence, the use of computer simulations in classroom is practical, effective and amenable to widespread implementation.

Akpan (2012) equally conducted a study to examine the impact of using a computer simulation model of an earthworm dissection as a preliminary experience to an actual dissection. To assess whether a simulation used before actual dissection could improve learning of anatomy. Akpan (2012) equally conducted a study to examine the impact of using a computer simulation model of an earthworm dissection as a preliminary experience to an actual dissection. These students had some prior experience in animal dissection, but had no experience in the use of a simulated interactive dissection. The study used intact classes and was randomly assigned to their classes at the beginning of academic school year in a manner to roughly equalize ability across sections. The basic design was a two group pre-treatment and post-treatment comparison using the traditional wet lab hands-on method of dissection as the control treatment before or after students used the interactive computer simulation of dissection as the experimental treatment. The result of the study revealed that a simulation used before dissection led to better achievement performance than a simulation used after dissection.

Van Eck and Dempsey (2012) also carried out a study on testing a computer simulation designed to facilitate transfer of mathematics skills from a learning context to a real-world scenario. The simulation software was developed using Macromedia Authorware 5.1 for Microsoft Windows® 95/98 and incorporated interactive video as a vehicle for providing contextualized advisement to learners. The population for this study was 7th and 8th grade students ranging in age from 12 to 15 years. From the population a sample of 123 students was selected from four middle schools in an American Gulf Coast city. Students were then randomly assigned to a control group or one of four treatment groups. All students were administered a 16-item survey which collected a range of demographic data including age, gender, computer experience, mathematics experience, game playing behavior, etc. A 23-item pretest was then administered to all students to verify that all participants possessed the basic mathematic skills necessary to address the problems presented in the simulation. The result of the study shows that students in the treatment group with contextual advisement achieved greater skills transfer. This study seems to indicate that simulations can facilitate learning transfer in a classroom setting in which the simulation approximates a situated learning context. The work of Van Eck and Dempsey lends support to the efficacy of simulations as a vehicle for delivery of situated learning experiences to the traditional classroom.

Rai and Lai (2014) carried out a research on the effect of using computerised simulation on students' business knowledge. WA high school students were grouped into six teams of tens with equal amount of female and male students, country and metropolitan students and private and state schools students. There were 40 (67%) female and 20 (33%) male, 10 (17%) year ten and 50 (83%) year eleven, 43 (72%) private school and 17 (28%) state school and 45 (75%) metropolitan and 15 (25%) country students. The study was designed around the existing structure and organisation of the Rio Tinto Business Studies Summer School run by Murdoch University. It was a five-day programme with two mentors for each team guiding students' discovery of how the computerised simulation worked in a co-operative setting. Results showed that all students significantly improve their business knowledge after working with the computerised simulation.

Based on the results of empirical research studies reviewed on computer simulation in this section, it appears that computer simulation can be as effective and as efficient a medium for delivery of instruction as non-simulation experience. Therefore, it appears that students who use computer simulation seem to make greater gains than students who do not. However, despite the significant results recorded in other subjects, not much has been done on computer simulation using mathematics as a content focus. Thus, this study tends to find out the effect of computer simulation on students achievement in algebra.

2.3.2 Studies on gender as a factor in mathematics achievement

Several studies have been carried out to ascertain whether or not gender influences students' academic achievement. Differences in researchers' opinions abound as regard gender differentiation.

Adeleke (2017) carried out a study that examined the problem solving performance of male and female students' mathematical problem-solving performances using Conceptual Learning Strategy (CLS) and Procedural Learning Strategy (PLS).A sample of 124 science students assigned into CLS, PLS and Conventional Method (CM) groups were involved in the study making use of pretest, post test control group design. The sample was drawn from three intact Senior Secondary School Two (SSII) classes from three local government Areas of Osun State in Nigeria and were taught for a period of eight weeks. Findings of the study showed a non significant difference in the performance of boys and girls in the two learning strategies. But a significant difference was recorded in the performance of boys when comparing the two groups also in the performance of girls in the two groups. The study therefore concluded that when training of problem solving is carried out in mathematics using Conceptual and Procedural Learning Strategies boys and girls will perform equally well without significant difference.

Bassey, Joshua and Asim (2008), also carried out a study on gender inequality in the mathematics achievement of rural male and female students in Cross River State, Nigeria; and whether parental socio-economic status and school proprietorship, taken independently, are significant factors in the achievement of the students. By stratified and simple random sampling, 2000 students (50% males, 50% female) were selected and a 30-item four option multiple choice mathematics achievement test (MAT) was constructed (KR20 of 0.87 and item difficulty, $0.40 < p < 0.82$) and administered. The first finding revealed the existence of significant gender achievement gap in favour of the rural male students.

Kurumeh & Achor (2010) equally carried out a study that determined the effect of Cuisenaire Rods' approach on some Nigeria primary pupils' achievement in decimal fractions. A total of 200 Primary six pupils (that is, 6th grade) from randomly selected schools in Makurdi metropolis of Benue State of Nigeria served as the sample for the study. A Mathematics Achievement Test on Decimal Fractions (MATDF) developed by the researchers and validated by three experts with a reliability coefficient of 0.89 using K-R 21, was used for data collection. Two way Analysis of Covariance was used for analyzing the data. The results revealed that there was no significant difference between male and female pupils taught using Cuisenaire Rods approach ($F1, 199 = 3.453; p > .05$).

Kurumeh (2017) also carried out a study to examine the differential effect of ethnomathematics approach on the interest of male and female students. A sample of 400 JSS II students were randomly selected from four single sex secondary schools (200males and 200female) in Ogidi and Aguata educational zones of Anambra State. An instrument on mathematics Interest Inventory on Geometry and Mensuration (MIIGM) constructed by the researcher was used for data collection. Data collected were analysed using mean, standard deviation and ANCOVA. The result revealed that female students benefited more significantly than their male counterparts in interest in geometry and mensuration.

Ezeugo & Agwagah (2010), carried out a study to determine the effect of concept mapping on students' achievement in algebra. They also determined the differential effect of concept mapping on the achievement of boys and girls in algebra. The study sample consisted of 387

S.S.II students from eight intact classes randomly selected from four secondary schools- two female and two male schools, in Onitsha Educational Zone of Anambra State. Data were collected using the Algebraic Achievement Test (AAT). Result from the study revealed that male students in the experimental group achieved more in the achievement test than female students.

Some researchers on gender issues have proposed that gender differences on academic achievement are related to how well define a problem is. Results of such studies indicate that female students do better on problems that are well defined and for which the method of solution is straight forward while male students tend to do better on problems that are not well defined and which require less standard types of solution. The researcher therefore deemed it necessary to carry out this present study to see if a clearer picture will emerge on gender in mathematics achievement.

2.3.3 Studies on interest as a factor in academic achievement

Interest is an important variable in academics and that is the reason researchers find it necessary to carry out studies on it.

Ogbonna (2013), carried out a study on students' interest in mathematics using constructivist instruction approach. The study adopted a quasi-experimental design referred to as pre-test post test control group design. The sample for his study was the number in the intact classes of SS 1 students he used. Data were collected using mathematics achievement test (MAT) and Quadratic Equation Interest Scale (QEIS). Result from the study revealed that the constructivist instructional approach has a differential effect on the interest of male and female students.

Iheanyi (2012), also investigated a study on students' interest in mathematics (Geometry) using peer assessment technique. The study was carried out in Okigwe educational zone of Imo state. A quasi-experimental non-equivalent control group design was used for the study. The sample for the study consisted of 227 students drawn from four schools. Data were collected using Geometric Achievement Test (GAT) and Geometric Interest Scale (GIS).The result from the findings revealed that the interest of students taught with peer assessment technique was higher than those taught with teacher assessment.

Thomas (2015) studied students' interest in biology and the relationship between traditional and constructivist teaching in college biology. Two large section of introductory biology for non majors in biology were given the same course information with two different teaching styles. One group (N=86) was presented material in the traditional teacher-centered manner of lecture method while course information was given to the second group (N=98) in the students' centered constructivist method. Learning was assessed in both groups with the same evaluative instrument and the results compared. The analysis revealed that the experimental group did significantly better than the control group. The students in the experimental group maintained a better attitudes, interest and enjoyed the introductory course more than the students in the control population.

These studies reviewed indicated that students' interests were enhanced with the different approaches used. This preset study therefore tries to find out if using computer simulation will enhance students' interest in algebra.

2.4 Summary of Reviewed Literature

The review of literature related to this topic was done under the subheadings; conceptual framework, theoretical and empirical studies. Under conceptual framework, computer simulation, the nature of simulation and interest as a factor in academic achievement were reviewed. Under the theoretical framework, Bruner theory of learning was reviewed and under the empirical studies, closely related studies were also reviewed.

From the discussion so far, it can be deduced that computer simulation is a potent instructional tool for promoting meaningful learning. It has been adopted by several researchers who have employed it at all levels in different disciplines. The question then is will computer simulation be a potent instructional tool for promoting meaningful learning in mathematics?

Moreover, it is evident from the foregoing that the position that mathematics occupies in the national policy on education and its role towards technological advancement has put it in a special place in primary, secondary and tertiary levels of education. Despite all the recognition accorded mathematics at all levels of the system; students' performance had continued to be poor. Several researchers have attributed this problem to poor teaching methods adopted by teachers, thus advocating for more viable methods that will arouse students' achievement and interest. Interest as a factor in academic achievement as it relates to mathematics was discussed. There were opinions of researchers and writers as regards to what interest implies. The literature also reviewed some of the factors that affect interest and their implications to teaching and learning, more so, that of mathematics.

Also, gender has been identified as a potent factor influencing students' achievement in mathematics. It is the aim of this study to explore the effect of using computer simulation approach on students' achievement in mathematics, to check whether there is any difference in the achievement of male and female students in mathematics as a result of the approach. The study also aims at finding out what the influence of computer simulation will be on the interest of male and female students in relation to their achievement. Therefore, will computer simulation approach significantly improve students' achievement and interest in mathematics?

CHAPTER 3

RESEARCH METHODOLOGY

This chapter is discussed under the following research procedures: Research Design, Area of study, Population of the study, Sample and Sampling Technique, Instrument for Data Collection, Validation of the Instrument, Reliability of the Instrument and Method of Data Analysis.

3.1 Research Design

The Design of the study is quasi-experimental study or a non-equivalent control group design. According to Nworgu (2016) quasi-experiment is an experiment where random assignment of subjects to experimental and control groups is not possible. In this case, intact or pre-existing groups were used.

3.2 Population of the Study

The population of the study covers 540 Junior Secondary School Two (JSSII) students within Bosso Local Government Area, Minna, Niger State.

3.3 Sample and Sampling Technique

The sample for the study was 54 students (27 students as experimental group and 27 students as control group) were sampled in the classes of the JSS II students of 2020/2021 academic session. Purposive sampling technique was employed to sample two schools. The reason for purposively selecting two schools is because only the two schools have computer facilities and electricity. The two schools selected had up to two streams of JSS II students and from each school, one class was chosen through simple random sampling. Again simple random sampling technique was used to select two intact classes from the schools selected. The researcher with a flip of a coin determined which of the intact classes become the experimental group and the one that becomes the control group.

3.4 Research Instruments

The researcher employed two instruments for the study; they are the Teacher Made Algebra Achievement Test (TMAAT) and Algebra Interest Inventory (AII). The Algebra Achievement Test was developed by the researcher following the table of specification. The TMAAT consisted of 20 multiple choice test items covering the three methods of Solving Equations. Out of the 20 questions, 7 were of higher order while 13 were of lower order. This achievement test was piloted and revised by experts in the field before administering it to the 54 students.

The pretest was administered one week before the experiment while the post test was administered after the experiment.

The Algebra Interest Inventory is a 20-item interest inventory developed by the researcher. It has a 4-point response scale. The scale and the scoring are shown below:

Strongly Agreed (SA)	-	4
Agreed (A)	-	3
Disagree (D)	-	2
Strongly disagree (SD)	-	1

The Pre-Algebra Interest Inventory was administered to the students immediately after the Pre-Teacher Made Algebra Achievement Test while the Post-Algebra Interest Inventory was administered to the students immediately after the Post-Teacher Made Algebra Achievement Test.

3.5 Validity of the Instruments

The Teacher Made Algebra Achievement Test (TMAAT) was subjected to content and face validation while the Algebra Interest Inventory (AII) was subjected to construct validation approach. The content validation of TMAAT was ensured through strict adherence to the test blue print. The test blue print was also validated by experts in Mathematics Education and Measurement and Evaluation in Department of Science Education from FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

3.6 Reliability of the Instrument

The researcher carried out a trial testing of the Teacher Made Algebra Achievement Test and Algebra Interest Inventory to estimate the internal consistency or reliability coefficient of the instruments. The instruments were administered to a class of J.S.S II students from a school close to one of the schools selected for the study. One intact class of 44 students was used for the trial testing.

The internal consistency of the Algebra Achievement Test was determined using Kuder Richardson Formula 20 (K-R 20) method. Kuder Richardson was used because the test items involved multiple-choice items. The internal consistency coefficient $r = 0.98$ was gotten.

Again Cronbach's Alpha method, which is a modified version of K-R 20 formula was used to establish the reliability of the Algebra Interest Inventory. The internal consistency of the AII was computed as 0.76.

3.7 Method of Data Analysis

The research questions were answered using means(x) and standard deviation (S.D).

Hypotheses were tested at 0.05 level of significance using Analysis of covariance (ANCOVA).

The researcher with the use of a software package known as Special Package for Social Sciences (SPSS) was used for the calculations.

CHAPTER FOUR

RESULTS AND DISCUSSION

The purpose of this study was to investigate the effect of computer simulation on achievement and interest of students in algebra at JSS II. The results of this study are presented in this chapter according to the research questions and hypotheses stated.

4.1 Descriptive Analysis

Research question 1

What is the mean achievement scores of students taught with computer simulation and those taught with conventional approach in the Algebra Achievement Test (AAT)?

Table 4.1.1: The mean achievement scores of students taught mathematics using computer simulation and conventional approach

Subject		Pre test		Post test	
Group	**No. of Students (N)**	**Mean ($\bar{X}$)**	**Standard Deviation (SD)**	**Mean ($\bar{X}$)**	**Standard Deviation (SD)**
Experimental	27	47.8524	24.2214	74.4321	19.1205
Control	27	39.6199	24.5722	48.4572	19.5245
TOTAL	54				

From the data above, the experimental group which represents those taught with computer simulation approach, obtained a higher mean achievement score of 47.8524and a standard deviation of 24.2214in pre test (PREAAT) and a mean score of 74.4321and a standard deviation of 19.1205 in the post test (POSTAAT). While the control group representing those taught with the conventional approach, it was observed that they had a mean score of 39.6199and a standard deviation of 24.5722in the pre test while in the post test, they had a mean achievement score of 48.4572and a standard deviation of 19.5245. The better performance of the experimental group over that of the control group showed that students taught mathematics using computer simulation learnt mathematics concept better than those taught mathematics by the conventional method.

Research question 2

What are the mean achievement scores of male and female students taught using the computer simulation in the Algebra Achievement Test (AAT)?

Table 4.1.2: The mean achievement scores of male and female students taught mathematics using computer simulation and the conventional approach

Group	Subject No. of Students (N)	Pre test Mean ($\bar{X}$)	Pre test Standard Deviation (SD)	Post test Mean ($\bar{X}$)	Post test Standard Deviation (SD)
Male	12	53.5213	20.1003	32.2354	17.1184
Female	15	43.1134	26.2413	68.4321	18.4567
TOTAL	27				

Table 4.1.2 revealed that the male students had a mean score of 53.5213 and a standard deviation score of 20.1003 in the pre test and a mean score of 32.2354 and a standard deviation of 17.1184 in the post test. While their female counterparts had a mean score of 43.1134 and a standard deviation score of 26.2413 in the pre test and a mean score of 68.4321 and a standard deviation score of 18.4567 in the post test. The result above showed that the mean achievement scores of males in both the pre test and post test scores were significantly higher than their female counterpart.

Research question 3

What is the mean interest scores of students taught with computer simulation and those taught with conventional approach in the Algebra Interest Inventory (AII)?

Table 4.1.3: The mean interest scores of students taught mathematics using computer simulation and the conventional approach

Group	Subject No. of Students (N)	Pre test Mean ($\bar{X}$)	Pre test Standard Deviation (SD)	Post test Mean ($\bar{X}$)	Post test Standard Deviation (SD)
Experimental	27	2.5207	1.2567	3.7654	0.78645
Control	27	2.6543	0.8654	2.9991	0.9999
TOTAL	54				

From table 4.1.3, it is observed that the interest score of the experimental group had a mean score of 2.5207and a standard deviation of 1.2567 for the pre test (PREAII) and a mean score of 3.7654 and standard deviation of 0.78645 for the post test (POSTAII). For the students taught with the conventional method (control group), it was observed that they had a mean interest score of 2.6543and a standard deviation of 0.8654 for the pre test while a mean interest score of 2.9991 and a standard deviation of 0.9999 for the post test. The higher mean interest score for the experimental group over the control group showed that the experimental group showed more interest in algebra than the control group as indicated in their interest mean scores in AII.

Research question 4

What are the mean interest scores of male and female students taught using the computer simulation in the Algebra Interest Inventory (AII)?

Table 4.1.4: The mean interest score of male and female students taught mathematics using computer simulation and the conventional approach

	Subject	Pre test		Post test	
Group	**No. of Students (N)**	**Mean ($\overline{X}$)**	**Standard Deviation (SD)**	**Mean ($\overline{X}$)**	**Standard Deviation (SD)**
Male	12	3.7654	0.7654	3.9875	0.6543
Female	15	2.4328	0.8963	3.7654	0.7654
TOTAL	27				

Table 4.1.4 revealed that the male students had a mean interest score of 3.7654 and a standard deviation score of 0.7654 in the pre test (PREAII) and a mean score of 3.9875 and a standard deviation of 0.6543 in the post test (POSTAII). While their female counterparts had a mean interest score of 2.4328 and a standard deviation score of 0.8963 in the pre test and a mean score of 3.7654 and a standard deviation score of 0.7654 in the post test. This implies that the male students showed greater interest in algebra than the female students.

Testing of Research Hypothesis

Hypothesis (HO_1)

There is no significant difference between the mean achievement scores of students taught with computer simulation and those taught with conventional method, as measured by the Algebra Achievement Test (AAT).

Table 4.1.5: Summary of ANCOVA Result for AAT

Source of variation	**Type III Sum of squares**	**DF**	**Mean sum of square**	**F**	**Sign**
Intercept	1827.168	1	1827.168	117.757	.000
Pre test	7996.957	1	7996.957	54.958	.000
Groups	5907.574	1	5907.574	39.905	.000
Sex	948.3313	1	948.3313	6.701	.015
Group* Sex	27.3232	1	27.3232	.191	.692
Error	7222.324	49	147.3944		
Total	23929.6775	54			

The result of the analysis in table 4.1.5 above showed that there is a significant difference in the mean achievement scores of students taught algebra with computer simulation and those taught the same topics using conventional approach. In other words the null hypothesis of no significant difference was rejected.

Hypothesis (HO_2)

There is no significant difference between the mean achievement scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Achievement Test (AAT).

Table4.1.6: Summary of ANCOVA Result for AAT for male and female students taught with computer simulation.

Source of variation	**Type III Sum of squares**	**DF**	**Mean sum of square**	**F**	**Sign**
Intercept	13851.258	2	13851.258	67.956	.000
Pre test	2474.406	1	2474.406	12.140	.002
Sex	424.343	1	424.343	2.082	.162
Error	4891.844	24	203.827		
Total	153650.000	27			

The result on table 4.1.6 above shows that gender was not significant. Thus, the null hypothesis of no significant difference for gender was not rejected since sex was not significant.

Hypothesis (HO_3)

There is no significant difference between the mean interest scores of students taught algebra with computer simulation and those taught with conventional method, as measured by the Algebra Interest Inventory (AII).

Table 4.1.7: Summary of ANCOVA Result for AII

Source of variation	Type III Sum of squares	DF	Mean sum of square	F cal	Sign
Intercept	27.5444	1	27.5444	45.518	.000
Pre interest	.149	1	.149	.245	.622
Groups	11.299	1	11.299	18.672	.000
Sex	.574	1	.574	.948	.335
Group* Sex	.237	1	.237	.391	.534
Error	29.651	49	.605		
Total	571.000	54			

The result of the analysis in table 4.1.7 above showed that treatment was significant. Thus the null hypothesis of no significant difference in the mean interest scores of students taught Algebra with computer simulation and their counterparts taught same topics using conventional approach was rejected.

Hypothesis (HO_4)

There is no significant difference between the mean interest scores of male and female students taught with computer simulation in algebra, as measured by the Algebra Interest Inventory (AII).

Table 4.1.8: Summary of ANCOVA Result for AII for male and female students taught with computer simulation

Source of variation	Type III Sum of squares	DF	Mean sum of square	F	Sign
Intercept	21.598	1	21.598	81.031	.000
Pre interest	.003	1	.003	.011	.918
Sex	.076	1	.076	.286	.598
Error	6.397	27	.267		
Total	355.000	27			

The result on table 4.1.8 showed that gender was not significant. Thus the null hypothesis of no significant difference for gender was not rejected since sex was not significant.

Hypothesis (HO_5)

There is no significant interaction effect between computer simulation and gender on students' achievement in Algebra.

The result on table 4.1.5 above showed that the interaction effect due to computer simulation approach and gender (Group * Sex) was not significant. Thus the null hypothesis of no significant interaction effect between the computer simulation approach and gender on students' achievement was not rejected.

Hypothesis (HO_6)

There is no significant interaction effect between computer simulation and gender on students' interest in algebra.

The result on Table 4.1.7 above showed that the interaction effect between the computer simulation approach and gender on student's interest was not significant. Thus the null hypothesis of no significant interaction effect between the computer simulation approach and gender on students' interest was not rejected.

4.2 Discussion of Findings

In this chapter, the researcher discussed the findings of the study based on the research questions and hypotheses that guided the study.

Research question one and three were intended to find out the mean achievement and the mean interest scores of students that were taught with computer simulation and those taught the same topics using conventional approach. Analysis of the result as shown in table 4.1.1 for research question one indicated that the mean achievement scores of students in the experimental group was significantly higher than the mean achievement scores of the control group both in the pretest and the posttest scores.

Analyses of the result as shown in table 4.1.2 for research question two showed that the mean achievement scores of males in both the pretest and post test scores for experimental and control groups were significantly higher than their female counterparts.

Result from table 4.1.3 for research question three showed that there was a higher mean interest score for the experimental group taught with computer simulation over the control group taught using conventional approach. Research questions three and four were sought to find out the mean achievement scores and the mean interest scores of male and female students in algebra. In table 4.1.4, the result showed that the mean interest scores were in favour of males in pretest and post test in both the experimental and control groups.

The result of this study agrees with the findings of Timbade and Wagh (2008), Akpan (2012), Van Eck and Dempsey (2012) and Rai and Lai (2010) who indicated that students taught using computer simulation performed significantly better in achievement than those taught using the conventional approach. The significance difference of the computer simulation approach over the conventional approach in the algebra topics taught could be attributed to the fact that computer simulation approach could provide such properties as interaction. In other words, the students participate actively and work interactively with the computer simulation programme thereby increasing students' interest and awareness in the lesson.

Hypothesis one sought to find whether a significant difference existed between the mean achievement scores of students taught algebra using computer simulation and their counterpart taught same topics using conventional approach. For the first hypothesis there was a significant difference in the mean achievement scores of students taught algebra using computer simulation approach thereby rejecting the first hypothesis.

The second hypothesis was to determine whether there existed a significant difference in the mean achievement scores of male and female students taught algebra using computer simulation and their counterpart taught using the conventional approach. With regards to the hypothesis, table 4.1.5 showed that gender was not rejected and the hypothesis was accepted.

The third hypothesis was to determine whether there existed a significant difference in the mean interest scores of students taught algebra using computer simulation approach and their counterparts taught same topics using conventional approach. With regards to the hypothesis, Table 4.1.6 showed that there was a significant difference in the mean interest scores of students taught with computer simulation. Therefore, the hypothesis was rejected.

Hypothesis four sought to find out whether a significant difference exited in the mean interest scores of male and female students. With regards to the hypothesis, table 4.1.6 showed that gender was significant at .335 and the hypothesis was not rejected.

Hypothesis five sought to find out whether there existed a significant interaction effect between the teaching method (computer simulation) and gender on students in algebra topics taught. The findings on table 4.1.5 showed that there was no significant interaction effect between teaching method and gender.

Hypothesis six sought to find out whether a significant interaction effect existed between computer simulation approach and gender in students interest in algebra topics taught. With regards to hypothesis six, the findings on table 4.1.6 showed that there was no interaction effect between computer simulation approach and gender on students' interest on algebra topics taught and this led to the acceptance of the hypothesis.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter deals with the summary of findings, conclusion, recommendations, limitations, contribution of study to existing knowledge and suggestion for further study.

5.1 Summary

This study investigated the effect of computer simulation on achievement and interest of students in algebra at junior secondary school level. The instrument used consisted of the Algebra Achievement Test (AAT), Algebra Interest Inventory (AII) and a Lesson Plan for both experimental and control group. AAT was a multiple-choice test that had twenty items each with four options; developed from Linear equations. The topics included Equations by balance method, Equations with brackets and Equations with fractions. The AII was also a twenty item interest inventory on the above topics. Experts from mathematics education and measurement and evaluation in the department of science education of the University of Nigeria, Nsukka face validated the test blue print and consequently the instruments for the study.

A quasi-experimental, non-equivalent control group design was used in carrying out the research; the researcher used all the JSS II students in Isoko north educational zone of Delta State as the population of the study. Fifty-four students, from two schools (male and female) sampled, were used as sample for the study. The student in their intact classes were each assigned by balloting to either experimental or control group; and separately taught by their regular mathematics teachers who had earlier been trained for the purpose. Identified extraneous variables which could pose potential threat to the validity of the study were controlled. All the groups were pre and post tested.

Four research questions and six hypotheses guided the study. Mean, Standard deviation and analysis of covariance (ANCOVA) was used in data analysis. The results showed that the use of computer simulation approach in teaching influenced students' achievement and interest in algebra. The results had some implications for students, mathematics teachers, parents, textbook Authors and publishers likewise the state and federal government.

Recommendations were made based on the findings and implications of the results which included the incorporation of computer simulation by Authors and publishers of mathematics textbooks, massive production of computer simulation programmes in various mathematics topics by mathematics experts. There is need for the organization of workshop and seminars by MAN and STAN for teachers to enhance proper mastery and effective utilization of computer simulation in the teaching and learning of mathematics.

5.2 Conclusion

The result of this study established the following

1. The use of computer simulation approach significantly enhanced students' achievement in algebra topics taught more than the conventional approach. This was observed in the mean score of the experimental group being higher than that of the control group.
2. There is a significant difference between the mean achievement scores of male and female students both in the pretest and posttest in favour of males.

3. There is no significant interaction effect between the teaching method and gender on students' achievement and interest in algebra topics taught.
4. The mean interest score was higher for both pretest and posttest scores in favour of the experimental group.

5.3 Recommendations

In view of the findings of this study and their implications the following recommendations are made.

1. Mathematics experts should be encouraged and funded by government for the production of computers and computer simulation programmes in various mathematics topics for schools.
2. The state and federal ministries of education should invest on massive acquisition and distribution of computers machines and mathematical software to secondary schools.
3. Mathematics textbook authors and publishers should incorporate the use of computer simulation approach in their text books. This will avail the teachers and students the opportunity in developing interest on the need of computer simulation in their lessons.
4. There is need for the establishment and equipment of Educational Resource Centres in each education zone of the state. Such Centres will provide avenues for collection of computer simulations in various mathematics topics that are relevant and suitable in the teaching and learning of mathematics.
5. Professional organizations like the Science Teachers Association of Nigeria (STAN) should organize workshops, seminars and conferences to train mathematics teachers on the importance of computer simulation in the teaching and learning of mathematics.

6. Parents/Guardians are advised to procure computer simulation in various mathematics topics for their children. Such instructional materials will arouse, motivate and enhance the interest of students in the learning of mathematics.

5.4 Contribution of Study to Existing Knowledge

The findings of this study have a number of implications for students, mathematics teachers, curriculum planners, authors and publishers of mathematics text books, Ministry of Education, Post-Primary School Management Board, State and Federal government.

Since the mean achievement scores of male students were higher than those of the female students, it then implies that both male and female students should be encouraged to learn algebra by using computer approach in the teaching-learning process since there was a significant difference in the mean achievement scores of students taught algebra using computer simulation approach. Mathematics teachers have a role to introducing computer simulation approach in the teaching-learning process since there was a significant difference in the mean achievement scores of students taught algebra using computer simulation approach.

The study has the implication for parents to purchase the computer simulation programme for their children such that they can interact and practice at their own pace and in the absence of a teacher thereby increasing the interest of students and making learning effective and motivating.

An implication of this study is that mathematics teachers should use computer simulation approach to arrest the problems of overloading of available mathematics teachers due to the imbalance in teacher-pupil ratio that have necessitated the inability of teachers to cover the mathematics topics.

5.5 Suggestions for Further Study

1. Further investigation should be carried out to deter mine the effect of computer simulation on other branches of mathematics.
2. A study may be carried out to investigate the attitude and achievement of students towards the use of computer simulation and the conventional approach.
3. A similar study may be carried out to investigate the effect of computer simulation on students' achievement, interest and retention in mathematics.
4. A similar study should be conducted using school location as a variable. For instance, schools from the urban and rural areas respectively should be used in the study.

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APPENDIX 1

TABLE OF SPECIFICATION OR TEST BLUE PRINT

N/S	**Content Dimension**		**Ability Process Dimension**		
			Lower Cognitive Process	Higher Cognitive Process	**Total**
		%	**60**	**40**	**100**
1	Solving Equations by the Balance Method (Linear)	30	4 (1,3,5,6)	2 (2,4)	6
2	Equations with Brackets (Linear)	30	4 (8,9,10,12)	2 (7,11)	6
3	Equations with Fractions (Linear)	40	5 (13,14,18,19,20)	3 (15,16,17)	8
Total		**100**	**13**	**7**	**20**

APPENDIX 2

QUESTIONNAIRE ON THE EFFECTS OF COMPUTER SIMULATION ON JUNIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND INTEREST IN ALGEBRA IN BOSSO LOCAL GOVERNMENT AREA OF NIGER STATE

Time Allowed: 1hour 30mins

Dear Student,

I am a researcher from Federal University of Technology Minna researching on the **Effect Of Computer Simulation On Junior Secondary Students achievement and interest Algeria** in Bosso

Local Government Area of Minna, Niger State.

I will appreciate if you could complete the questionnaire as information obtained concerning this study will remain confidential.

Thank you.

SECTION A:

BIO-DATA INFORMATION

1. Gender: Male ( ) Female( )

2. Age bracket: 9 – 11 years ( ) 12 -15 years ( )

Section B

Instruction: Please, Choose the Correct Answers From The Options Lettered (a – d)

1. Solve 9+2r = 16

   (a) r = 7/2 (b) r = 2 (c) r = 6 (d) r = 7/3

2. A number is multiplied by 6 and then 4 is added. The result is 34. Find the first number.

   (a) x = 7 (b) x = 5 (c) x = 3 (d) x = -5

3. Solve 3x – 8 = 10

   (a) x = 6 (b) x = 3 (c) x = 2 (d) x = 1

4. A rectangle is 8m long and its perimeter is 30m. Find the breath of the rectangle.

   (a) b = 7 (b) b = 5 (c) b = 6 (d) b = -3

5. Solve 4x – 1 = 1

(a) x = 2 (b) x = 1 (c) x = 2/3 (d) x = ½

6. Solve 4 + 5a = 19

(a) a = 3 (b) a = 8 (c) a = 2 (d) a = -2

7. Solve 2(y-2) + 3(y-7) = 0

(a) y = 5 (b) y = -5 (c) y = 7 (d) y = 2

8. Solve 2(4-x) = 3(2-x)

(a) x = -2 (b) x = -3 (c) x = -4 (d) x = 2

9. Solve 15 = 3(x-3)

(a) x = 4 (b) x = 8 (c) x = 7 (d) x = 6

10. Solve 3x + 1 = 2(3x + 5)

(a) x = 3 (b) x = 2 (c) x = -2 (d) x = -3

11. Solve 5(x-4) – 4(x+1) = 0

(a) x = 24 (b) x = 19 (c) x = 18 (d) x = 2

12. Solve 0 = 7(x-3)

(a) x = 7 (b) x = 2 (c) x = 3 (d) x = 1

13. Solve the equation 4/3 = 2z/15

(a) z = 10 (b) z = 9 (c) z = 5 (d) z = 6

14. Solve the equation 5 + a = 6

(a) a = 1 4 (b) a = -1 (c) a = 0 (d) a = 2

15. Solve the equation 3(2a+1) = 5(a+5)

(a) a = ½ 4 (b) 6 a = 3/8 (c) a = 20/8 (d) a = 41/8

16. Solve the equation 5e - 1 – 7e + 4 = 0

(a) e = 2 4 (b) 8 e = 4 (c) e = -2 (d) e = -4

17. Solve the equation x/2 – x/3 = 2

(a) x = 24 (b) x = 12 (c) x = 6 (d) x = 3

18. Solve the equation 2a-1 – a+5 = 1

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

19. Solve the equation x/5 = ½

(a) $x = ½$ (b) $x = 3/2$ (c) $x = 5/2$ (d) $x = 4/2$

20. solve the equation $x-2 = 4$

1

(a) $x = 14$ (b) $x = -14$ (c) $x = 7$ (d) $x = -7$

APPENDIX 3

SOLUTION TO THE TMAAT/ MARKING SCHEME

1. A
2. B
3. A
4. A
5. D
6. A
7. A
8. A
9. B
10. D
11. A
12. C
13. A
14. A
15. D
16. A
17. B
18. C
19. C
20. A

Each correct answer attracts 1 mark.

APPENDIX 4

ALGEBRA INTEREST INVENTORY FOR JUNIOR LEVEL

This inventory is designed to help you express your feelings towards solving equations. Consider each statement and then tick against each number the point which best expresses your feelings or how much you like the topic.

The four point scales are: Strongly Agree (SA), Agree (A), Disagree (DA) and Strongly Disagree (SD).

S/N	ITEMS	SA	A	D	SD
1	I enjoy solving problems on simple equation.				
2	When I hear the word equation I have feeling of dislike.				
3	I like attending lessons on solving equations.				
4	I do assignment on equations regularly because of likeness.				
5	Equation with fractions is my most hated topic in Solving equation.				
6	I like answering questions on solving equation lessons.				
7	Solving problems on equations is very interesting.				
8	I encourage other students to attend algebra lessons.				
9	I really like solving equations.				
10	Solving equations with bracket makes me feel secure				
11	I sleep during equation lessons.				
12	Lessons on solving equations are not always interesting.				
13	I feel sense of insecurity when I am attempting a problem on Algebra.				

14	Other topics are more important to me than solving equations.				
15	Equation with fractions is a boring aspect of Solving equation in algebra.				
16	I am happier studying solving equation than other topics.				
17	It makes me nervous to even think on how to tackle any problem in solving equations.				
18	Solving equations should be removed from mathematics syllabus because it is boring.				
19	The feelings I have towards Algebra is a good one.				
20	Balance method is my best topic in solving equations in Algebra because it is interesting.				

APPENDIX 5

LESSON NOTE FOR EXPERIMENTAL GROUP

Subject: Mathematics

Topic: Solving Equations by the Balance Method

Class: JSS II

Time: 60 minutes

Instructional Aids: chalk, chalkboard, text book, computer and computer simulation software (Microsoft math)

Instructional Objective: By the end of the lesson, students should be able to solve equations by balanced method.

Content Development	Teachers Activities	Students Activities	Strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. **Step two:** The teacher tests the previous knowledge by giving the students a simple equation to solve, i.e. Solve X-2=10.	Students solve the equation in their exercise books.	Note taking and questioning.
	Step three: The teacher introduces the day's lesson by writing "solving equations by balanced method" on the chalkboard. **Step four:** The teacher explains by telling students that 2x-9=15 is an equation in X. X is the unknown in the equation. 2x-9 is on the left-hand side (LHS) of the equal sign and 15 is on the right-hand side (RHS) of the equal sign. Therefore, to solve an equation means to find the value of the unknown that makes the equation true. Example Solve 2x-9=15	Students pay attention and ask questions. They also put the solutions down in their note books.	Listening and questioning.

	Solution 2x-9=15 Add 9 to both sides 2x-9+9=15+9 2x=24 Divide both sides by 2 to keep the balance of the equation. 2x/2=24/2 X=12 Therefore X=12 is the solution of the equation 2x-9=15	Students are given other examples to solve.	

	Step five: The teacher at this stage takes the students to mathematics laboratory or computer room where he uses computer simulation software (Microsoft math) to demonstrate how the computer can do the manipulation of solving equations by balance method. He goes further to demonstrate its computational power and also to show to the students that the computer simulation programme (Microsoft math) can manipulate symbolic expressions or equations and find their values.	Students watch and pay attention with enthusiasm and also are allowed to handle the mouse and the keyboard to practice the teachers demonstration .	Demonstration, learning by doing and questioning.
	Step six: the teacher evaluates by giving the students assignment. Solve, using balanced method 1. 3x-8=10 2. 4+5a=19		

LESSON NOTE FOR CONTROL GROUP

Subject: Mathematics

Topic: Solving Equations by the Balance Method

Class: JSS II

Time: 40minutes

Instructional Aids: chalk, chalkboard and text book

Instructional Objective: By the end of the lesson, students should be able to solve equations by balanced method.

Content Development	Teachers Activities	Students Activities	strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. The teacher tests the previous knowledge by giving the students a simple equation to solve, i.e. Solve x-2=10.	Students solve the equation in their exercise books.	Note taking and questioning.
	Step two: The teacher introduces the day's lesson by writing "solving equations by balanced method" on the chalkboard. **Step three:** The teacher explains by telling students that 2x-9=15 is an equation in x. x is the unknown in the equation. 2x-9 is on the left-hand side (LHS) of the equal sign and 15 is on the right-hand side (RHS) of the equal sign. Therefore, to solve an equation means to find the value of the unknown that makes the equation true. Example Solve 2x-9=15 Solution 2x-9=15 Add 9 to both sides	Students pay attention and ask questions. They also put the solutions down in their note books.	Listening and questioning.

	2x-9+9=15+9 2x=24 Divide both sides by 2 to keep the balance of the equation. 2x/2=24/2 X=12 Therefore X=12 is the solution of the equation 2x-9=15	Students are given other examples to solve.	
	Step four: The teacher evaluates by giving the students assignment. Solve, using balanced method 1. 3x-8=10 2. 4+5a=19		

LESSON NOTE FOR EXPERIMENTAL GROUP

Subject: Mathematics

Topic: Equations with Brackets

Class: JSS II

Time: 60 minutes

Instructional Aids: chalk, chalkboard, text book, computer and computer simulation software (Microsoft math)

Instructional Objective: By the end of the lesson, students should be able to solve equations with brackets.Content Development	Teachers Activities	Students Activities	strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. **Step two:** The teacher tests the previous knowledge by giving students an equation to solve using balance method. i.e. Solve the equation 7c–6=1.	Students solve the equation in their exercise books.	Note taking and questioning.
	Step three: The teacher introduces the lesson by writing "equations with bracket" on the chalkboard. He goes further to tell students that in solving equations with brackets they should always remove brackets before collecting terms. <u>Example</u>	Students pay attention and ask questions. They also put the solutions down in their	Listening and questioning.

	Solve 3(3x-1) = 4(x+3) Solution: 3(3x-1) = 4(x+3) Remove brackets 9x-3 = 4x+12 Subtract 4x from both sides, and add 3 to both sides. 9x-4x-3+3 = 4x-4x+12+3 5x = 15 Divide both side by 5 5x/5 = 15/5 X = 3	note books. Students are given other examples to solve.	

	Step four: The teacher at this stage takes the students to mathematics laboratory or computer room where he uses computer simulation software (Microsoft math) to demonstrate how the computer can do the manipulation of solving equations with brackets. He goes further to demonstrate the computational power of the computer.	Students watch and pay attention with enthusiasm and also are allowed to handle the mouse and the keyboard to practice the teachers demonstration.	Demonstration, learning by doing and questioning.
	Step five: the teacher evaluates by giving the students by giving them class work. Solve the following 1. 2(x+5) = 18 2. 15 = 3(x-3) 3. 2(3y+1) = 14	Students copy down the class work in their exercise books and begin to work.	

LESSON NOTE FOR CONTROL GROUP

Subject: Mathematics

Topic: Equations with Brackets

Class: JSS II

Time: 40minutes

Instructional Aids: chalk, chalkboard and text book

Instructional Objective: By the end of the lesson, students should be able to solve equations with brackets.

Content Development	Teachers Activities	Students Activities	strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. **Step two:** The teacher tests the previous knowledge by giving students an equation to solve using balance method. i.e. Solve the equation 7c–6=1.	Students solve the equation in their exercise books.	Note taking and questioning.
	Step three: The teacher introduces the lesson by writing "equations with bracket" on the chalkboard. He goes further to tell students that in solving equations with brackets they should always remove brackets before collecting terms. Example Solve 3(3x-1) = 4(x+3) Solution: 3(3x-1) = 4(x+3) Remove brackets 9x-3 = 4x+12 Subtract 4x from both sides, and add	Students pay attention and ask questions. They also put the solutions down in their note books.	Listening and questioning.

	3 to both sides. 9x-4x-3+3 = 4x-4x+12+3 5x = 15 Divide both side by 5 5x/5 = 15/5 X = 3	Students are given other examples to solve.	
	Step four: the teacher evaluates by giving the students class work. Solve the following 1. 2(x+5) = 18 2. 15 = 3(x-3) 3. 2(3y+1) = 14	Students copy down the class work in their exercise books and begin to work.	

LESSON NOTE FOR EXPERIMENTAL GROUP

Subject: Mathematics

Topic: Equations with Fraction

Class: JSS II

Time: 60 minutes

Instructional Aids: chalk, chalkboard, text book, computer and computer simulation software (Microsoft math)

Instructional Objective: By the end of the lesson, students should be able to solve equations with Fractions.

Content Development	Teachers Activities	Students Activities	strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. **Step two:** The teacher tests the previous knowledge by giving students an equation to solve i.e. Solve the equation $7(2e+3) = 3(4e+9)$.	Students solve the equation in their exercise books.	Note taking and questioning.
	Step three: The teacher introduces the lesson by writing "equations with fractions" on the chalkboard. He goes further to tell students that in solving equations with fractions always clear fractions before collecting terms. To clear fractions, multiply both sides of the equation by the LCM of the denominator of the fractions. Example Solve the equation $4m/5 - 2m/3 = 4$ Solution:	Students pay attention and ask questions. They also put the solutions down in their note books.	Listening and questioning.

	4m/5 – 2m/3 = 4 The LCM of 5 and 3 is 15 Multiply both sides of the equation 15 i.e. multiply every term by 15. 15*(4m/5)-15*(2m/3) = 15*4 3*4m – 5*2m = 15*4 12m-10m = 60 2m = 60 Divide both sides by 2 2m/2 = 60/2 m = 30	Students are given other examples to solve.	

	Step four: The teacher at this stage takes the students to mathematics laboratory or computer room where he uses computer simulation software (Microsoft math) to demonstrate how the computer can do the manipulation of solving equations with fractions. He goes further to demonstrate the computational power of the computer.	Students watch and pay attention with enthusiasm and also are allowed to handle the mouse and the keyboard to practice the teachers demonstration .	Demonstration, learning by doing and questioning.
	Step five: the teacher evaluates by giving the students home work from their text books.		

LESSON NOTE FOR CONTROL GROUP

Subject: Mathematics

Topic: Equations with Fraction

Class: JSS II

Time: 40minutes

Instructional Aids: chalk, chalkboard and text book,

Instructional Objective: By the end of the lesson, students should be able to solve equations with Fractions.

Content Development	Teachers Activities	Students Activities	strategies
Entry Behaviour	**Step one:** The teacher allows students some seconds to settle down while he wipes the board. **Step two:** The teacher tests the previous knowledge by giving students an equation to solve i.e. Solve the equation 7(2e+3) = 3(4e+9).	Students solve the equation in their exercise books.	Note taking and questioning.
	Step three: The teacher introduces the lesson by writing "equations with fractions" on the chalkboard. He goes further to tell students that in solving equations with fractions always clear fractions before collecting terms. To clear fractions, multiply both sides of the equation by the LCM of the denominator of the fractions. Example Solve the equation 4m/5 – 2m/3 = 4 Solution: 4m/5 – 2m/3 = 4	Students pay attention and ask questions. They also put the solutions down in their note books.	Listening and questioning.

	The LCM of 5 and 3 is 15 Multiply both sides of the equation 15 i.e. multiply every term by 15. 15*(4m/5)-15*(2m/3) = 15*4 3*4m – 5*2m = 15*4 12m-10m = 60 2m = 60 Divide both sides by 2 2m/2 = 60/2 m = 30	Students are given other examples to solve.	
	Step four: the teacher evaluates by giving the students home work from their text books.	.	

APPENDIX 6

CALCULATION OF INTERNAL CONSISTENCY RELIABILITY COEFFICIENT OF THE TMAAT SCORES

Scores	**P**	**Q**	**PQ**
13	0.65	0.35	0.2275
12	0.6	0.4	0.24
11	0.55	0.45	0.2475
8	0.4	0.6	0.24
8	0.4	0.6	0.24
11	0.55	0.45	0.2475
11	0.55	0.45	0.2475
12	0.6	0.4	0.24
12	0.6	0.4	0.24
12	0.6	0.4	0.24
13	0.65	0.35	0.2275
16	0.8	0.2	0.16
17	0.85	0.15	0.1275
17	0.85	0.15	0.1275
18	0.9	0.1	0.09
19	0.95	0.05	0.0475

19	0.95	0.05	0.0475
19	0.95	0.05	0.0475
16	0.85	0.2	0.17
15	0.75	0.25	0.1875
0	0	0	0
20	1	0.95	0.95
9	0.45	0.55	0.2475
15	0.75	0.25	0.1875
14	0.7	0.3	0.21
6	0.3	0.7	0.21
15	O.75	0.25	0.1875
3	0.15	0.85	0.1275
17	0.85	0.15	0.1275
18	0.9	0.1	0.09
12	0.6	0.4	0.24
14	0.7	0.3	0.21
5	0.25	0.75	0.1875
19	0.95	0.05	0.0475
4	0.2	0.85	0.17
2	0.1	0.9	0.09
11	0.55	0.45	0.2475

18	0.9	0.1	0.09
10	0.5	0.5	0.25
1	0.05	0.95	0.0475
15	0.75	0.25	0.1875
17	0.85	0.15	0.1275
8	0.4	0.6	0.24
19	0.95	0.05	0.0475
			1882.969

K-R 20 = $\left\{\frac{n}{n-1}\right\}\left\{\frac{\sigma t^2 - \sum pq}{\sigma t^2}\right\}$

where n = number of item in test

p = proportion of individuals who passed each item

q = proportion of individuals who failed each item

$\sum$= summation of

σt^2= variance of the total score on test.

K-R 20 = $\left\{\frac{44}{44-1}\right\}\left\{\frac{4307.51 - 1882.969}{4307.51}\right\}$

K-R 20 = $\left\{\frac{44}{43}\right\}\left\{0.956283778\right\}$

K-R 20 = 1.02 × 0.96 = 0.98 **K-R 20** **= 0.98**

APPENDIX 7

RELIABILITY RESULTT FOR FOUR POINT SCALE USING

CRONBACH ALPHA TO TEST FOR INTERNAL CONSISTENCY (SPSS)

Reliability

Scale: ALL VARIABLES

Case Processing Summary

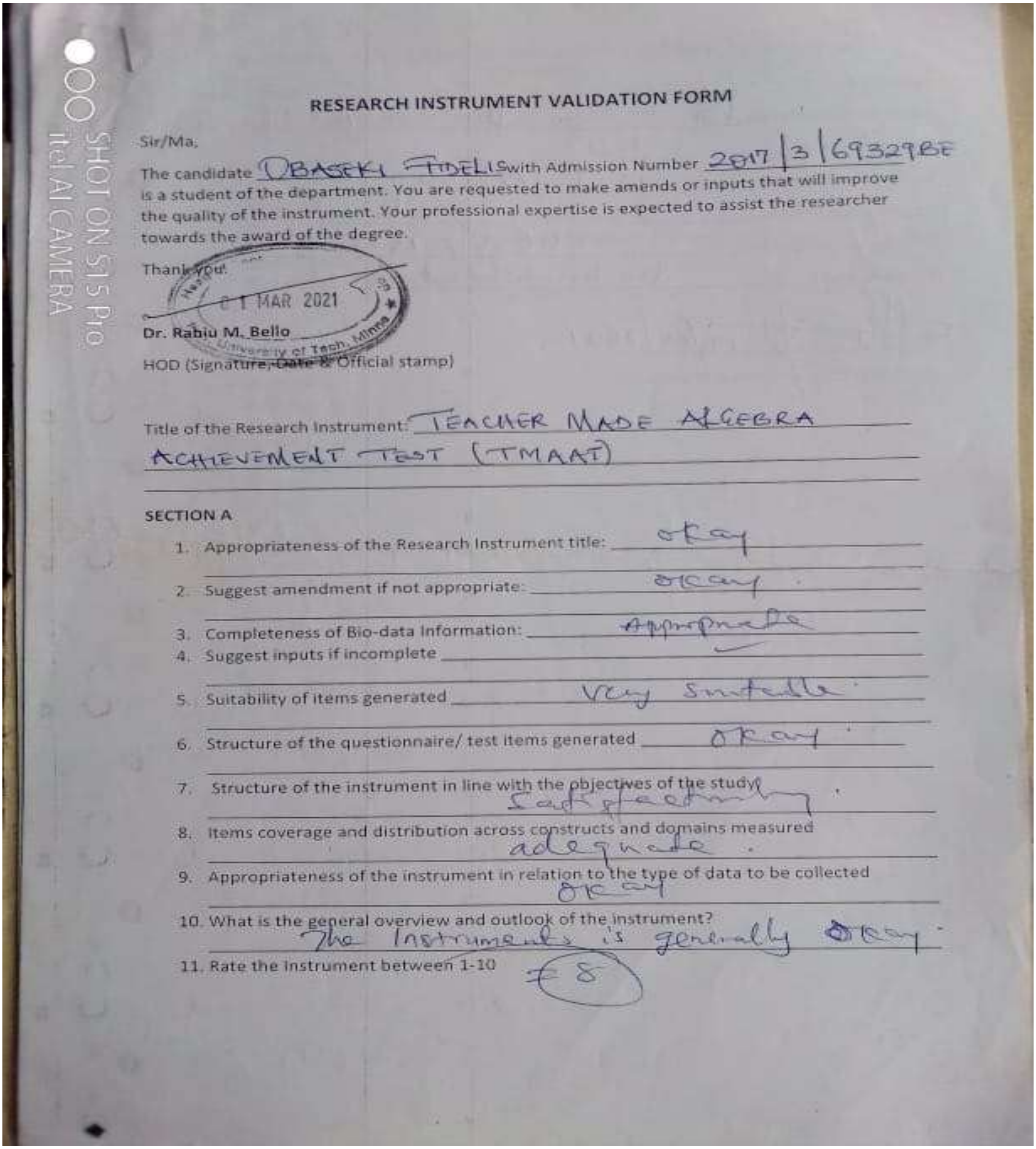
		N	%
Cases	Valid	54	100.0
	Excluded[a]	0	.0
	Total	54	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.759	.756	20

APPENDIX 8



RESEARCH INSTRUMENT VALIDATION FORM

Sir/Ma,

The candidate OBASEKI FIDELIS with Admission Number 2017/3/69329BE is a student of the department. You are requested to make amends or inputs that will improve the quality of the instrument. Your professional expertise is expected to assist the researcher towards the award of the degree.

Thank you.

01 MAR 2021

Dr. Rabiu M. Bello

HOD (Signature, Date & Official stamp)

Title of the Research Instrument: TEACHER MADE ALGEBRA ACHIEVEMENT TEST (TMAAT)

SECTION A

1. Appropriateness of the Research Instrument title: okay
2. Suggest amendment if not appropriate: okay
3. Completeness of Bio-data Information: Appropriate
4. Suggest inputs if incomplete —
5. Suitability of items generated very suitable
6. Structure of the questionnaire/ test items generated okay
7. Structure of the instrument in line with the objectives of the study Satisfactorily
8. Items coverage and distribution across constructs and domains measured adequate.
9. Appropriateness of the instrument in relation to the type of data to be collected okay
10. What is the general overview and outlook of the instrument? The Instruments is generally okay.
11. Rate the instrument between 1-10 8