DEVELOPMENT OF 2D ANIMATION TO ENHANCE THE COGNITIVE ABILITY OF JUNIOR SECONDARY SCHOOL STUDENTS IN GEOMETRY

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2015/1/58789BT

A PROJECT SUBMITTED TO THE DEPARTMENT OF EDUCATIONAL TECHNOLOGY, SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA IN PARTIAL FULFILMENT OF THE REQUIREMENTSFOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (B.Tech) IN EDUCATIONAL TECHNOLOGY

APRIL, 2023

ABSTRACT

This study is aimed at the development of 2D animation to improve the cognitive ability of junior secondary school students in Geometry. Four research questions were raised and answered and three research hypothesis was formulated and tested. The target population for the study consisted of all the JSS1 mathematics students in Gurara, Niger State. The sample size for the study is eighty-four (84) students which consisted of sixty-four (64) male students and twenty-four (24) female students. The sample size was ascertained using intact classes and balloting was used to assign the experimental and control groups. The instrument for data collection titled Test of Logical Thinking (TOLT) and 2D animation and Interest Checklist (2IC) were used for data collection. The instruments were validated by educational technology experts and a reliability test was carried out using the the Kuder Richardson reliability coefficient and Cronbach alpha which gave reliability index of r=0.89 and r=0.78 respectively. The researcher administered the instrument to both the experimental and control groups. The findings revealed that there was significant difference between the mean cognitive scores of students taught Mathematics using 2D animation package and those taught using conventional method. The fndings revealed there was significant difference between the mean retention scores of students taught Mathematics using 2D animation package and those taught using conventional method, there was no significant difference between the mean cognitive scores of male and female students taught Mathematics using 2D animation package. The findings also revealed that there was no significant difference between the mean retention scores of male and female students taught Mathematics using 2D animation package. The study made recommendations amongst others, which included that in-service training should be organized for teachers so that they learn the process of producing 2D animation package and the use of modern instructional media for effective instructional delivery.

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CHAPTER ONE

1.0 INTRODUCTION

1.1Background to the Study

In order to first define Geometry, there is a need to define mathematics as it is the subject that embodies Geometry. Yadav (2017) referred to mathematics as the queen of science which means to develop the thinking power and reasoning intelligence, which sharpens the mind and makes it creative. The development of human beings and their culture depend on the development of mathematics. This is why it is known as the base of human civilization. It is also the language of all material science and the centre of all engineering branches which revolve around it. Sophia (2018) defined mathematics as the science of number (or) space" (OR) "The science of measurement, quantity and magnitude" According to "New English Dictionary" "Mathematics – in a strict sense – is the abstract science which investigates deductively the conclusions implicit in the elementary conception of spatial and numerical relations."

Geometry is a branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids. geometry, the branch of mathematics concerned with the shape of individual objects, spatial relationships among various objects, and the properties of surrounding space (Heilbron, 2020). It is one of the oldest branches of mathematics, having arisen in response to such practical problems as those found in surveying, and its name is derived from Greek words meaning "Earth measurement." Eventually it was realized that geometry need not be limited to the study of flat surfaces (plane geometry) and rigid three-dimensional objects (solid geometry) but that even the most abstract thoughts and images might be represented and developed in geometric terms.

Despite the said importance of Geometry; Yadav (2017) noted that students continue to fear mathematics as a subject. Mathnasium (2018) observed that there are 3 major reasons students struggle with Geometry:

1. They don't understand and can't apply the vocabulary to decode the problem.
2. They can't see or recognize all of the pieces that go into making up the geometry problem.
3. They struggle with the Algebra skills involved in doing Geometry, which means they didn't retain some of their skills from last year.

Most Geometry problems are given in terms of pictures. It is probably one of the first times in a student's Mathematical career that the problem hasn't been completely spelled out for them. If they don't pick up on the subtle clues given in the picture, they aren't able to decode the problem. The information they need is all there, they just don't recognize it as useful. Vocabulary plays a critical role in this process. If you don't know what a bisector is and what it does, how are you going to be able to solve a problem involving one? Sarabi et al. (2018) observed that students consider science subjects as abstract, hence there should be ways to enhance the learning of Geometry through technological means that could help improve academic performance.

Cognitive ability is defined as a general mental capability involving reasoning, problem solving, planning, abstract thinking, complex idea comprehension, and learning from experience (Ispas&Borman, 2015). Mayfield (2011) observed that an individual's cognitive ability provides the foundation for his or her innovative capabilities. Such cognitive abilities include intelligence, perseverance, creative thinking ability, and even pattern recognition. Cognitive ability refers to the functioning usually considered to be a person's mental faculties. In general, the higher an individual's cognitive abilities, the more able that person is to develop innovations and

implement innovations from other sources. Allemand (2019) argued that cognitive abilities are key competences that are needed to meet the challenges of job demands, education, and advanced training, societal expectations, and the demands of everyday life of middle-aged adults. Cognitive skills are the core skills your brain uses to think, read, learn, remember, reason, and pay attention. Working together, they take incoming information and move it into the bank of knowledge you use every day at school, at work, and in life (LearningRX, 2021).

With the emergence of the computer age, information, and communication (ICT) devices has attracted serious attention to the field of education. Technology is developing rapidly in the 21st century and these developments are bringing many innovations in education as well. The use of technology in education also affects learning and teaching environments (Ghavifekr, 2015). It has been suggested that with the use of animation in education, there is a significant increase in the attitudes and academic achievements of the students in a positive way (Baglama et al., 2018). It has been shown that animations as technological tools used in education have contributed a lot to the students in terms of security, speeding and slowing time, examining very rare events, simplifying complicated systems, being useful and cheap and motivation as well as providing a significant increase in students' attitudes and academic achievements towards the courses in positive manner. Emerging technologies and needs have caused visuality to become more prominent over time (Baglama et al., 2018). The rapid development of the information also results in the failure of a recently produced knowledge to become dysfunctional. This requires timely and effective use of information. In this case, tools were needed to make available information accessible by large masses quickly and effectively without waiting for the existing information to get old. Sharing and using information is as important as producing information. Therefore, there is a need for information dissemination systems that save time and money for

sharing and using information produced by the large masses. As a result of this, the work of visualization and visualization systems has become important (Zabukovec&Jakliç, 2015) Animation as a multimedia tool is at the forefront of the visualization systems. Experts in the field of educational technology have proposed several ideas on how technology can be effectively used to enhance the teaching and learning process. Li et al (2018) noted that the use of animation significantly improved students' cognitive ability. Animation is a technical process that, in general, produces motion illusion in the viewer by sequencing the still images produced in the analogue or digital environment in sequence. As a way of producing a film as much as it is technically possible, the development of the animation, which is included in the genre film itself, can now go beyond the judgment that it is mainly an entertainment for the mass audience of children (Baglama et al., 2018). The realization of 2D animation appealing to people of all ages has been influential in bringing the concept of animation out of the audience's perception of traditional animation films by giving them brand new dimensions. Santhanam et al. (2009) concluded that animation is superior to text-based representations and reduces students' cognitive load only in learning tasks where animations have a good cognitive fit.

Ebele (2017) are of the opinion that achievement is a fundamental aspect of everyday life, affecting people's work, interpersonal relationships, sense of being, and leisure. Academic achievement could be seen as the level of performance in a particular field of study. Davidson (2017) saw academic achievement as high scores obtained by students in an examination. The high scores are indices, symbols or marks which characterize the students 'achievement. It is an indication of amount or level of knowledge an individual learner possesses in a given subject area as opined by Guskey and Pollio (2017). On the other hand, cognitive ability is the individuals 'capacity to think, reason, and solve problem. It is the capacity to perform higher

mental processes of reasoning, remembering, understanding, and problem solving in teaching and learning process (cognitive ability- Brooking's institution). Also according to Smith (2011) cognitive ability is the biology-based differences in the make-up of human brain that affect the capacity of an individual to benefit from instruction. Cognitive ability influences the rate, quantity, and quality of learning. It also affects how students transfer and retain what they have learnt in classrooms. Psychologists classify cognitive ability in to high, average, low cognitive levels. Student's ability in a learning task is usually grouped into these categories. Cognitive ability is measured through tests of intelligence and cognitive skills. Aiyedun (2010) reported that there is a difference between the mean performances in mathematics of students with high academic ability and those with low academic ability while Ezeugwu*et al.*,(2021) showed that ability levels have no significant effect on the achievement of students in essay writing. This study will also look at gender differences of studentsincognitive ability in senior secondary school financial accounting.

Gender is a range of characteristics used to distinguish between male and female, particularly in the cases of men and women, masculine and feminine attributes assigned to them. Gender is a social construct, it is not biologically determined but a concept equivalent to race or class (Ezebuilo, 2020). This definition suggests that gender is socially or culturally constructed characteristics and role, which are associated with males and females in society. It is different from sex which is a biological distinction in appearance (morphology) and function (physiology) as well as reproductive contributions of men and women. According to Kachel (2016), gender is ascribed attribute that differentiates feminine from masculine. The difference in academic achievement due to gender differences is crucial to the educationists. Dania (2014) in a study from secondary schools in Edo south senatorial zone reported a significant difference in the

academic achievement of male and female students in mathematics while Kola and Taiwo, (2013) reported that boys performed better in physics. Mbaba (2010) found out no significant difference in the performance of boys and girls in introductory technology. This study would also investigate gender differences in financial accounting achievement. This is because studies in gender differences in relation to academic achievement have been carried out another subjects. However, achievement in relation to school location will be considered in this study.

1.2 Statement of the Research Problem

Various studies, including those by Chand et al. (2021) and Micheal (2018), have highlighted that students often experience fear and difficulty when it comes to mathematics, including geometry. Furthermore, the academic performance of mathematics students has been observed to decline, and this has been attributed to a range of factors such as poor teaching methods, lack of infrastructure and instructional materials, and poor attitudes of students towards mathematics.To address this issue, many educators have emphasized the importance of using artifacts of practice, such as student work or classroom videos, in the professional development of teachers. However, according to AMTE (2020), there is a need to further enhance the education of prospective mathematics teachers. One potential approach is to use animation tools to create scenarios that bring together student thinking and classroom artifacts, with the aim of improving the professional development of mathematics teachers.Geometry is a subject that involves shapes, and animations can be a powerful tool to accurately depict and illustrate these shapes. Unlike static drawings and pictures, animations can be viewed as videos, which increases motivation and stimulates learners by making the learning experience more fun and interactive.Therefore, the current study aims to develop 2D animations to improve the cognitive ability of junior secondary school students in geometry, particularly in Gurara, Niger State. This study recognizes

the potential of using animation tools as an effective way to enhance learning and teaching in mathematics, and hopes to contribute to the improvement of mathematics education for students in Gurara, Niger State.

1.3 Aim and Objectives of the Study

The aim of this study is the development of 2D animation to improve the cognitive ability of junior secondary school students in Geometry. Specifically, the study will achieve the following objectives: To.

i. Develop a 2D animation to teach Geometry.
ii. Determine the effect of 2D animation on the cognitive ability of students in junior secondary schools.
iii. Examine the gender difference of 2D animation on academic achievement of students in junior secondary schools.
iv. Investigate the pupil's level of interest towards 2D animation for teaching and learning of mathematics.

1.4 Research Questions

i. What is the mean achievement score of junior secondary school students taught using 2D animation and those taught without 2D animation?
ii. What are thegender differences of 2D animation on academic achievement of students in junior secondary schools?
iii. What is the level of interest of students taught using 2D animation?
iv. what are the gender difference in the interest level of students taught using 2D animation.

1.5 Research Hypotheses

The following research hypotheses were tested in the study.

H_{01}: There is no significant difference between the mean achievements score of students taught using 2D animation and students taught using conventional instruction.

H_{02}: There is no significant difference between male and female mean achievements score of students taught using 2D animation and students taught using conventional instruction.

H_{03}There is no significant difference between male and female students based on their interest level towards 2D animation.

1.6Significance of the study

The research being conducted on the use of 2D animation in teaching and learning has the potential to bring about significant benefits for a range of stakeholders including students, teachers, parents, the government, and the society at large.

For students, the findings of this study could help them overcome challenges or difficulties they are facing during teaching and learning. With the efficient use of ICT based technologies, such as animation and other relevant electronic learning technologies, students can better understand and retain what they have learned, leading to improved academic success in the subject in question. In addition, the use of animation and other electronic resources can help to stimulate students' interest and motivation in the learning process, making it more engaging and effective.

For teachers, the result of this research work could be immensely beneficial in the proper utilization of 2D animation in the classroom. The findings of this study can help to improve their pedagogical skills, enabling them to deliver better quality education and enhance their students' learning experience. The knowledge gained from this research can help teachers to develop innovative teaching methods and materials that integrate animation and other electronic resources to make learning more engaging and effective.

Parents and the society at large can also benefit from this research. Parents will realize the importance of 2D animation and electronic resources and how they directly stimulate their children's learning process. This knowledge can help parents to support their children's education and promote their academic success. The society at large can benefit from improved literacy levels, as well as enhanced comprehension and understanding skills among the population.

Furthermore, the result of this research work can serve as a reference source to the government when formulating and implementing policies that will improve teacher's competency and enhance national growth. By using the insights gained from this research, policymakers can develop evidence-based policies that support the effective use of ICT in education and ensure that teachers are adequately equipped to deliver quality education.

In summary, the research being conducted on the use of 2D animation in teaching and learning has the potential to bring about significant benefits to a range of stakeholders. From improving academic success and engagement among students to enhancing teachers' pedagogical skills, promoting parental involvement, and informing policymaking, the findings of this research work can have far-reaching implications for education and the society at large.

1.7 Scope of The Study

This study will focus on the development of 2D animation to improve the cognitive ability of junior secondary school students in geometry. The study will be carried out in junior secondary schools in Gurara, Niger State. It involves gathering reliable data from students in junior secondary schools on how 2D animation can improve cognitive ability of junior secondary school students and will last for a period of four (4) weeks.

1.8 Operational Definition of Terms

Animation is a technical process that, in general, produces motion illusion in the viewer by sequencing the still images produced in the analogue or digital environment in sequence.

Mathematics: The science of measurement, quantity, and magnitude

Geometry: a branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 Conceptual Framework

2.1.1 Nature and Scope of Mathematics

Mathematics is the key to understanding our world around us. It is perhaps the purest of the pure mental endeavor of humankind. Mathematics has been called the mother of all sciences; to me it is the backbone of all systems of knowledge. Mathematics is a tool that has been used by man for many years. It is a key that can unlock many doors and show the way to different logical answers to seemingly impossible problems.

Mathematics is obviously the most interesting, exciting, and useful, challenging, satisfying, inspiring, impressive, consistent, stimulating, and beautiful subject in existence! It is the science of patterns and order and the study of measurement, properties, and the relationships of quantities, using numbers and symbols. The concept of Mathematics is quantitative and geometrical in nature. This has given rise to diverse approaches to the teaching and learning of the subject in accordance with different purposes for which it is used (Naor, 2013). In trying to emphasize the importance of Mathematics to human 2 activities, Bangbose (2011) says that it is used as a measuring tool for calculation and numerical analysis in our everyday life. While Ikwuka and Chukwuemeka (2016) highlighted Mathematics instructional materials as all geometry objects or the means of communicating process that stores and distributes human experiences through quantitative reasoning. Under the 6-3-3-4 educational system in Nigeria, Mathematics is one of the core subjects for students at the senior secondary school level (NPE, 2013). It is a compulsory subject for all students at the Senior School Certificate Examination

(SSCE). Mathematics is necessary for anybody wishing to advance in any academic career, whether it is science or art.

2.1.2 Mathematics Curriculum in Nigeria

Baldeh (2010) stressed that Mathematics is undoubtedly, the most important subject in Nigerian education. The adoption of Mathematics as a crucial subject had been seen as a quantitative analysis that will foster wider communication in accuracy and computation of numbers and figures. It is perhaps appropriate to assert, that if mathematics is not studied in secondary schools, the quest of business, trade and quantitative analysis would not be possible. Omolewe (2009) observed that mathematics as a subject emanated in Nigeria in 1842 with the use of stones and sticks as countable objects used for addition and subtraction. He affirms that the so-called counting of object, were notably form of highly transactional and functional arithmetic adopted by trader along the coast of Nigeria. He further maintained that it was the missionaries who called it arithmetic in their bid to impact their religion, that is, Christianity in Nigeria. The reception of mathematics in Nigeria, despite the quantitative nature of the subject was received and institutionalized as a core subject in education, commerce, industry and administrate. Since, its arrival to date the subject has always some status on its student in the country. As a result of the credence according to mathematics to obtain any lucrative job in either the public or private sector, a pass in it was considered as sine qua non.

To be educated was in the eye of many to be good in mathematic. Awofala (2012) opined that the implementation and acceptance of mathematics in Nigeria Educational system started when it was adopted as a core subject in 1982 and the vehicle of badly needed manpower to run the monetary aspect of government services. In quick succession, the education ordinances and code of 1882, 1906, 1918 and 1926 were enacted with a view to promote arithmetic for general use.

The desire for a good sound knowledge in mathematics was ignited by the enthronement of the certification system for employment in the public as well as private sectors of the economy, a desire which was the main thrust of the education codes. Without doubt, the examination system bored fruit instantly bringing prosperity to those who successfully went through it and doom and gloom to those whose performance on the government requirement was considered unsatisfactory. This was the beginning of the warm interminable embrace of European education, Mathematics in particular, which today, more than 15 anything else has deeply engulfed the Nigeria nation but not without its quantitative deterioration.

The stipulating by the National policy of Education (2013) on the teaching of basic arithmetic in the first two years of the junior secondary school and after that, mathematics will be used for the last four years in junior secondary school. It has been found that students do well in mathematics during their junior secondary school years but immediately they progress to secondary schools. They will begin to lose interest in Mathematics. Ikwuka (2016) noted that mathematics learning is a complex, creative, goal-oriented process which requires hard work perseverance, interest, cooperation, and patience on the part of the learners. But student in today's secondary schools regard Mathematics as a daring subject that need no such concerted effort with the Slogan "the subject of death" which is to say that it is very hard to pass. Thus, it always carries mass failure both in internal and external examination, whether Junior and senior secondary certificate examinations.

Osunde (2010) noted that the National Policy of Education (2013) in Nigeria emphasized that our children be properly taught so that they can acquire quantitative skill and competences that would enable them function well and solve problem in the society. The accomplishment and realization of these important educational goals in Nigeria lies in new trend in educational

approach. To this end, different ways of learning and teaching have emerged emphasis tends to shift from teacher-centered to student-centered approaches through involving the use of instructional materials in the teaching and learning of subject. These new approaches to learning and teaching expose the students to conceptualization ad the effectively manage their own learning and reinforce their learning and transfer their training in practical situation.

The unique role played by mathematics in enabling human to develop mentally and perform effectively in the society has awaken in the people the need to learn not only the arithmetic aspect but also the quantitative and geometry analysis of the world in general, (Algani, 2022). The learning of mathematics usually occurs in an organized setting then it advances to a more complex nature. Though in most cases, mathematics can be acquired by individual mental ability the issue of quantitative reason connotes the learning of mathematics as a subject. For a serious learning and teaching, and better understanding of mathematics, there need to be an objective sets out by the government and it should be carried out by the teacher of the subject so as to achieve an aim at the end of the teaching.

The Objectives for Teaching Mathematics in School are:

i. To develop the mental skills which are a combination of skills of listening reasoning and observing.
ii. To help learner's identity number correctly without difficulties
iii. To be able to use number to solve questions.
iv. To be able to apply mathematical principles correctly.

The Mathematical syllabus focuses on five basic sections namely: Arithmetic, Trigonometry, business, geometry, and probability/statistics. These are to be carried out through learners

centered activities within communicative context. Such contexts should reflect real life situation outside classroom moreover, these should be relevant, interesting, and enjoyable. The objective recognizes the student's existing communicative competence that is what they have learned in the primary level. It recommends the revision of the previous and extension of the learning skills to secondary schools.

Akudolu (2010) observed that the mathematics are taught in schools for the purpose of human development, academic reason, quantitative competences, and economic reason. When an objective is been set out these are of mathematics should be recognized. Having considered educational objectives of teaching mathematics and the means of achieving the objective, we are going further to consider the role of teacher in the teaching process.

2.1.3 Methods of Teaching Mathematics

Baig (2015) outlined ten methods of teaching mathematics; they include the following:

i. **Lecture Method**: In this method, knowledge is delivered through a speech. This is the oldest and most important teaching method because it is always remained a part of all other instructional methodologies. In this method, a teacher takes part as an active participant and students are at the receiving end most of the time. That is why; it is a teacher centered approach. This is also referred to as direct instruction, training model, active teaching, and explicit instruction. Lecture method is not only used for teaching theoretical concepts, but it is also helpful for giving training of complex skills and procedures.
ii. **Inductive Method**: This method is also called scientific method in which we proceed from known to unknown, from specific to general and from example to rule or

formula. In this method based on induction, students are presented some similar examples or problems related to one particular domain. Then students try to establish a formula, rule, law, or principal by observing them. If a generalized result is true for those similar examples or problems then it would also be true for all other such kind of examples. This method is useful to introduce a new mathematical concept along with a formula or rule. Students who like the inductive approach can infer the more complicated rules or formulas. It is a student-centered approach because students play an active role in it.

iii. **Deductive Method**: This method is totally different from inductive method. In this method, we proceed from general to specific and from a rule to an example. Already constructed formulas, rules, methods, or principles are taught to the students and they apply them to solve the problems (Altintas&Ilgun, 2017). In this teaching approach, we can also prove a theorem with the help of undefined terms, defined terms, axioms, and postulates. Then with the help of that theorem along with different rules and principles, we can derive other theorems as well. It is used to solve those problems in which complicated procedures are not involved and they can be solved by applying different kinds of already established laws, methods, formulas, and principles directly. Such kind of problems can be found in all units of syllabus of mathematics at secondary level including sets, logarithms, algebra, matrices, variation, statistics, geometry, and trigonometry.

iv. **Heuristic Method**: The word heuristic was drawn from a Greek word “heurisco” which means “I find out”. Heuristic method is based on child’s psychology who always wants to discover something by himself or herself. That is why it is also known as

discovery method. Sometimes a teacher only focuses on delivering lectures through speech in which students do not actively participate and get bored most of the time. But in the heuristic method, students are encouraged to reach the solution by constructing the knowledge themselves. Teacher only facilitates them by raising relevant questions. That is why it is also called inquiry method. As students discover the solution under the guidance of a teacher so it is also known as guided discovery method or programmed instruction. So muchresearch (Isa &Mamman, 2019) have proved that heuristic or discovery method is more effective in teaching mathematics than expository approach.

v. **Analytic Method**: In this method, we analyse the problem first by breaking up the problem in small segments and then move towards solution. It is also called descriptive method. It leads us from the unknown part of the problem to something already known or given in the problem statement. This method emphasizes on why we are applying different kinds of operations and what is the relationship between the required solution and other portions of the problem (Thwink, 2014).

vi. **Problem Solving Method:** Instructional methodologies should improve reasoning ability in the students. In this way, they become capable to find out the solutions of different kinds of problems not only during the studies but in their daily routine matters as well. Every child has the curiosity to explore the things and this psychology of the children can be utilized in a better way through problem solving method. It is the most important instructional methodology for mathematics (Hooda et al., 2018). Bruner, Oliver, Greenfield and Gagne, the most famous psychologists, also gave the top priority to this method. In this method, students are given such problems which

cannot be solved easily, or their solutions are not obvious. A student tries to reach the goals or solutions through the set of events or procedures. Gagné calls these events or procedures as lower order capabilities in which formulas, rules and concepts are used from which a student is already familiar. According to him, what the student learns is called a higher order principle which is the result of lower order capabilities.

2.1.4 Concept of Instructional Materials

Instructional materials refer to those alternative channels of communication, which a classroom teacher can use to concretize a concept during teaching and learning process (Amadioha, 2009). They are used by the teacher to empahsize on what is being taught by transforming abstract information into concretized learning. Shukla (2020) defined it as resources that organize and support instruction, such as textbooks, tasks, and supplementary resources. He referred to them as "human and non-human materials and facilities that can be used to ease, encourage, improve and promote teaching and learning activities". Instructional materials can also be considered as those items that assist the information aspect of teaching. Some examples of instructional material include textbooks, worksheets, 3D models, realia, mockups, charts, graphs, puppets, infographics, diorama etc.

Muraina (2015) defined instructional materials as human and non-human materials and facilities that can be used to ease, encourage, improve, and promote teaching and learning activities. They are whatever materials used in the process of instruction especially with the classroom for teaching and learning. They are a broad range of resources which can be used to facilitate effective instruction, they indicate a systematic way of designing, carrying out and employing the total process of learning and communication and employing human and non-human resources to bring out a more meaningful and effective instruction. In essence they are the human and non-

human material that a teacher uses to pass information to the learners in his/her class. They generally make teaching and learning easier and less stressful, they are equally indispensable catalysts of social and intellectual development of the learners.Instructional materials are the tool used in educational lessons, which includes active learning and assessment, basically any resource a teacher uses to help him teach his students can be considered as an instructional material (Study.com, 2015).

2.1.5 Classification of instructional materials

Instructional materials can be classified into seven broad groups, in order of increasing technical sophistication (Igwe, 2016). These groups are printed and duplicated materials;non-projected display materials; still projected display materials; audio materials; linked audio and still visual materials, cine and video materials, computer-mediated materials.

i. Printed and duplicated materials: These comprise all textual and other materials that can be run off in large numbers on a duplicator or printing machine for use by students. Facilities for the production of such materials are now available in practically every college, and they have become one of the most basic and widely used of all educational tools. Some of the more important types are listed below.

Handouts: these comprise all the different types of information-pro-viding materials that are given out to students, usually in connection with a taught lesson or programme of some sort; they include sets of notes (either complete or in skeleton form), tables, diagrams, maps and illustrative or extension material.

Assignment sheets: these include such things as problem sheets, reading lists, lab. sheets, briefing sheets for projects and seminars, worksheets, etc; they can be used in practically all types of instructional situations.

Individualized learning materials: these comprise all the different types of textual materials that are used in connection with individualized learning; they include study guides, structured notes, textual programmed materials, and textual support materials for mediated learning systems.

Resource materials for group exercises: these comprise all the various printed and duplicated materials that are used in connection with group learning exercises; they include background reading material, briefing material, role sheets, instruction sheets, datasheets, and so on.

ii. non-projected display materials: As its name suggests, this category includes all visual display materials that can be shown to a class, small group or individual student without the use of an optical or electronic projector of any sort. It includes a number of the most basic and most useful visual aids that are available to teachers and lecturers, some of the more important of which are listed below.

Chalkboard displays : displays that are written, printed or drawn on a dark-coloured surface using chalk; still one of the most widely-used of all visual aids, despite the fact that practically everything that can be done using a chalkboard can be done more easily, less messily, and (in most cases) more effectively using the overhead projector; probably most useful for displaying impromptu 'signposts', notes and diagrams during a taught lesson and for working through calculations and similar exercises in front of a class.

Whiteboard displays that are written, printed or drawn on a light-coloured surface using felt pens, crayons or other markers; these can be used in the same ways as chalkboard displays, and have the advantage of being less messy and offering a wider range of colours; also, a markerboard can double up as a projection screen if necessary.

Felt board displays: moveable displays that are produced by sticking shapes out out c` (or backed with) felt or some similar material to a board covered with felt, or to a sheet of felt pinned on to a wall; a comparatively cheap, highly portable and extremely useful display technique, especially in situations that require the movement or rearrangement of pieces (demonstrating table settings, carrying out sports coaching etc.)

Hook -And -loop board displays: similar to felt board displays, except that the backing material on the display items possess large numbers of tiny hooks that engage loops on the surface of the display board suitable for displaying heavier items than felt boards.

Magnetic board displays: displays consisting of items that are made of (or backed with) magnetic material or fitted with small magnets so that they stick to a ferromagnetic display board; can be used in much the same way as felt board and hook-and-loop board displays.

Flipcharts: large sheets of paper hung from an easel of some sort so that they can be flipped forwards or backwards in order to reveal the information on a particular sheet or produce a fresh blank sheet on which impromptu information can be written or drawn; individual sheets can be posted on walls to stimulate discussion.

Charts and wallcharts: largo sheets of paper, carrying pre-prepared textual and/or graphical and/or pictorial information. Such charts can either be used to display information during the

course of a lesson or can be pinned to the wall of a classroom or lecture room in order to be studied by the students in their own time. Wallcharts, in particular can be extremely useful for providing supplementary material or acting as a permanent aide memoire or reference system for learners (e.g. the periodic tables of the elements that are prominently displayed in practically all chemistry classrooms).

Posters: similar to wallcharts, but generally containing less information - often simply a single dramatic image; useful for creating atmosphere in a classroom.

Photographic prints: enlarged prints made from photographic negatives may be incorporated into textual materials, wallchartsetc., and, in linked sequences with suitable captions, can form a useful instructional medium in their own right; such sequences are particularly suitable for use in programmes designed for individual study.

Mobiles: systems of two-or three-dimensional objects that are hung from the roof of a class by thread, thus producing a visually attractive display whose shape is constantly changing due to air currents; particularly useful for creating interest among younger children.

Models: useful in cases where three-dimensional representation is necessary (e.g. crystal structures, animal skeletons, etc.) or where movement has to be demonstrated.

Dioramas: static displays that combine a three-dimensional foreground (e.g. a model landscape of some sort) with a two-dimensional background, thus creating an aura of solidity and realism.

Realia: displays of real items (e.g. geological or biological specimens) as opposed to models or representations thereof; extremely useful if such materials are readily available and easily displayed.

iii. Still projected display materials: This category includes all visual display materials which do not incorporate movement and which require an optical projector of some sort in order to show them to a class or group or enable them to be studied by an individual learner. It again includes some of the most useful visual aids that are available to teachers, instructors and trainers, the most important of which are listed below.

Overhead projector transparencies and similar materials: textual or graphical images on large acetate sheets that can either be displayed to a class or group using an overhead projector or viewed by individuals or small groups using a light box of some sort; probably the most useful and versatile visual aid that can be used to support mass instruction methods in the modern classroom.

Slides: single frames of 35 mm photographic film mounted in cardboard, plastic or metal binders, often between twin sheets of glass (compact slides) or larger images roughly 314 inches square (lantern slides - now largely obsolete); one of the most useful methods of displaying photographic or graphic images to a class, small group or individual student using a suitable front or back projector or viewer either singly or in linked sequences.

Filmstrips: these are simply strips of 35 mm film carrying linked sequences of positive images, each usually half the size of a standard 35 mm frame (half-frame, or single-frame filmstrips) but sometimes the full size (full-frame, or double-frame filmstrips); they are a convenient and (when purchased commercially) comparatively cheap alternative to slide sequences, and can be used in much the same ways, using suitable filmstrip projectors or viewers for display or study.

Microforms: microform is a general term for any medium that is used to carry micro-images, i.e. photographically-reduced images of pages of text, graphic materials, etc.; the most common

types are microfilms(rolls of strips of photographic film carrying a linear sequence of such images), microfiches (transparent sheets of photographic film carrying a matrix of such images) and micro cards (opaque sheets carrying similar matrices of micro images); all such microforms can be used to carry the frames of instructional programmes (e.g. programmed learning sequences),to act as highly compact data banks, etc., and can be studied using special magnifying viewers or projectors.

iv. Audio materials: This category includes all the various systems whereby straight for-ward audio signals can be played to a class or group or listened to by an individual. It again includes a number of extremely useful – albeit often neglected - instructional aids, some of the most important of which are described below.

Radio broadcasts: educational radio broadcasts constitute an extremely useful free resource for teachers and trainers, and, although they are often difficult to incorporate into the timetable if listened to at the time they are actually transmitted, this can easily be overcome by recording them for later playback; note, however, that it is only certain designated educational broadcasts that can be so used without infringing the copyright laws.

Gramophone records: recordings of music, plays, etc. on gramophone records again constitute a relatively inexpensive and readily-available instructional resource in certain subject areas, and are suitable both for playing to a class or group and for private listening by individuals, &though they are not so convenient to store, handle or use as tape cassettes.

Audiotapes: audio material recorded on an open-reel tape or tape cassette constitutes one of the most useful resources at the disposal of the modern teacher or lecturer; such material can be used

in a wide range of instructional situations, either on its own or in conjunction with visual materials of some sort.

v. Linked audio and still visual materials: This is the first of the two classes in which audio and visual materials are combined to form integrated instructional systems, and includes a number of media that are particularly suitable for use in individualized learning. Again, some of the most commonly-used systems are listed below.

Tape-slide programmes: audiotape recordings (usually on cassettes) synchronized with linked sequences of slides constitute one of the most commonly used integrated audiovisual media, and one of the most useful; they can be used in a wide range of instructional situations, particularly individualised learning.

Tape-photograph programmes: these are basically the same as tape-slide programmes, except that sequences of photographic prints are used instead of sequences of slides; their range of applications is rot so great, however, being largely restricted to individualised learning situations.

Filmstrips with sound: these are simply filmstrips that have an accompanying sound commentary, usually on a tape cassette; they can be used in much the same way as tape-slide programmes.

Radiovisionprogrammes: this is a technique pioneered by the British Broadcasting Corporation whereby still filmstrips are produced to accompany educational radio programmes; the filmstrips can either be shown to a class during the actual broad cast or used with a recording of same.

Tape-text: combinations of printed or duplicated materials with audio recordings constitute an extremely useful individualised learning technique; the audio component can either be carried on

a separate audiotape (usually a cassette) or carried on special strip or sheet that is incorporated in the medium that carries the text; the latter systems (known as audio cards, audio pages, talking pages, etc.) require specialized equipment to use them.

Tape-model, tape realia, etc.: combinations of audiotapes (usually cassettes) and still visual display materials such as three-dimensional models, collections of realia (e.g., geological and bio-logical specimens) and microscope slides; such hybrid systems can prove extremely useful vehicles for individualised learning. Linked audio and still visual materials are discussed in more detail in booklet number 16 in this series - "How to produce linked audio and still visual materials".

vi. Cine and video materials

This class includes all media that enable audio signals to be combined with moving visual sequences, thus enabling a further dimension to be added to integrated audiovisual presentations. The main systems that are currently available are as follows.

Cine films: such films have been in regular use in education and training for many years and are available in a number of formats; the most commonly used type is probably 16 mm, although 8mm and Super 8 mm films are also widely used, since they are much cheaper to make and show.

Loop films: these consist of loops of cine film (usually 8 mm) mounted in special cartridges that enable them to be shown or viewed continuously using a custom-designed projector or viewer; such loop films are ideal for teaching single concepts that require movement to demonstrate them

to full advantage, and, although they do not normally have an accompanying sound commentary, this can easier be added using a separate sound system.

Tape-film programmes: these are highly sophisticated integrated systems that enable audio material to be combined with sequences of still and moving pictures; most systems of this type use separate cassettes or cartridges to carry the audio and video components, and obviously require specialised equipment to show or view them.

Television broadcasts: as in the case of educational radiobroadcasts, educational television broadcasts constitute an extremely useful free resource for teachers and lecturers; like the former, they are not usually transmitted at convenient times, but, thanks to the development of relatively cheap videorecorders, this limitation can now be easily overcome; readers should again note, however, that it is only certain designated educational television programmes that can legally be recorded for subsequent educational use, and that an appropriate license is usually required even for this.

Videotape recordings: television sequences or programmes recorded on videotape now constitute one of the most useful and powerful instructional media at the disposal of teachers and lecturers and can be used in a wide range of teaching/learning situations.

Videodisc recordings: although not yet as widely used as video tapes and videocassettes, videodiscs (in which the signal is recorded optically or electronically on the surface of a special disc) have a tremendous potential in education and training. They will probably prove most important in Interactive video systems (see next section).

vii. Computer-mediated materials

This final category includes all the various materials that require a computer of some sort to enable them to be displayed, studied or used. Arguably, the computer constitutes the most important single resource ever to become available to teachers and lecturers since the invention of the printing press and may well have a similar revolutionary effect on the way education is carried out, bringing about the massive shift from conventional expository teaching to mediated individualised learning. Some of the main types of computer-mediated systems are listed below.

'Number crunching' and data processing packages: one of the most obvious uses of the computer in education is as a super calculator of a data processor; it is now possible to acquire or produce software packages that enable virtually any calculation or data processing task to be carried out automatically on the computer and when appropriately used, such packages can be of tremendous help to both teachers and learners.

'Substitute tutor' packages: another obvious use of the computer is as a vehicle for administering individualized learning, since it has the potential to provide a degree of interaction and feedback that no other system (apart from a real live tutor) possesses; thus, 'substitute tutor' computer-based learning packages seem certain to become one of the most important tools available to lecturers and students.

'Substitute laboratory' packages: a third important instructional application of the computer is as a vehicle for providing, through computer-based simulations, access to a far wider range of educational experiences than has ever been possible before; again, such 'substitute laboratory' packages seem certain to become increasingly important tools for lecturers and students of all types.

Database systems: as well as being used to process information, the computer can be used to store it, and to help retrieve it when required; thus, teachers and lecturers can now use computers to create data bases that can be used in a whole range of instructional situations.

Computer-managed learning systems: a fifth major application of computers in education is their use in an administrative or managerial role, e.g., in the overall administration of the system, timetable planning, budgetary control, and the management of the actual teaching/learning process; here again, software packages that enable these various things to be done are likely to become increasingly widely used.

Interactive video systems: such systems, which probably constitute the most powerful and potentially the most useful mediated instruction system yet developed, use a computer to gain access to video material stored in a random-access video recorder in the context of a fully interactive computer-based learning programme.

2.1.6 What are 2D Animation

Dictonary.com (n.d) defined two-dimensional (2D) animation: animation, or a product of animation, created when two-dimensional images are rapidly sequenced to create the illusion of lifelike motion, as in traditional drawn animation, cell animation, or computer-generated vector graphics. Stefyn (2019) defined 2D animation is the art of creating movement in a two-dimensional space. This includes characters, creatures, FX, and backgrounds. The illusion of movement is created when individual drawings are sequenced together over time. One second of time is usually divided into 24 frames. Depending on the style of animation there can be as many as 24 unique drawings in one second of animation (24fps) or as little as two. Conventionally animation is done on "2s" meaning there is a drawing every 2 frames (12fps). This allows artists

to save on production time/costs and gives 2D animation its unique look. Darvideo (n.d) defined 2D animation stands for the two-dimensional animation, meaning that characters and backgrounds in this kind of projects are created in the two-dimensional, flat space.

Pixelloid (2018) argued that 2D animation objects possess only the characteristics of width and height (no thickness) and are either drawn by hand or created on the computers. Another technique for 2D animation images creation is that of photographing still objects and then creating the sequence of frames. All original 2D animation was done by hand, with animators drawing each frame or cell. After all cells are completed, the sequence is edited and screened at the speed of 24 cels per second. This speed creates the illusion of movement natural for the human eye. Before the advent of computer-generated images and 3D technology, all cartoons and animated movies were produced in this way, while computer software now enables the generation of 2D images on a computer and their further manipulation for the animation effect.

While 3D animation is much more popular nowadays, the modern animation industry still applies 2D animation techniques to make 3D objects dynamic and realistic. Therefore, even with the advent of more innovative 3D animation, 2D is here to stay without the risk of becoming obsolete. 2D, or two-dimensional animation, is a combination of artistic technique and media design that creates the illusion of movement in a two-dimensional environment. By sequencing individual drawings together over time, characters, backgrounds, objects, and effects look as if they are moving. This is commonly done for animated movies and television, but it is also seen in video games, websites, mobile apps, and advertisements (Stefyn, 2019). 2D animation probably doesn’t need much of an explanation. It’s used to create flat, 2D characters and environments. While this is one of the oldest animation styles, its flexibility makes it a prominent choice for a variety of applications, including cartoons, promotional videos, explainer videos,

and more. In traditional animation, each frame was meticulously hand drawn, which can be very time-consuming. Today, animators have access to digital tools and techniques that help to streamline the 2D animation process (CreativeHumans, 2021).

2.1.7 Using 2D Animation to Teach

21st-century knowledge economy driven modern curriculum needs students to perceive complex dimensions of knowledge to be intellectually competent.Wickramasinghe and Wickramasinghe (2021) observed that animation is an excellent way of presenting academics in a less complicated form to students as the concepts can be presented lively and engaging students visually. It has been found out that the platform and the learning atmosphere impact on data mining. Their study was conducted with the main objective to assess the impact of using 2D animation as an effective teaching tool and to evaluate the most effective learning atmosphere for undergraduate studies, it was found out that there is a direct effect of using animated characters as a teaching tool and it was found out that using 2D animations add more value to the role of a lecturer when delivering through online platforms. This study's findings contribute towards emphasising how effective and innovative teaching techniques can be developed using 2D animations in a classroom environment. Thereby, through positive enhancement of the next generation of leaders' knowledge and attitudes in our country will increase the human intelligence assets in the knowledge-driven economy.

Aziz *et al*. (2019) revealed that Multimedia technology has opened up new opportunities and exploration to be exploited in the learning environment. This technology has the ability to integrate, combine, and deliver various media such as text, graphic, audio, video, animation and interactivity which can help make teaching and learning processes more effective and rewarding. A graphic representation of drawings is called animation which is to show movement within

those drawings. Animation is a series of drawings that are intertwined and slightly altered between individual frames, making it appear that the movements in the painting are smooth as they are replayed in rapid succession (24 frames per second). In a system of hypermedia, animations can be categorized in the 2D, 3D, combination of 2D and 3D, and metamorphosis. Besides that, they appear to be moving and real, which can place emphasis on performance to engage the learner and attract users‟ attention. Thus, to provide students with the same or better quality of experience as they use with traditional teaching methods, the environments of multimedia learning must be shown to be educationally effective. Therefore, with best such systems will be able to improve and enhance the quality of student learning. Since the invention of computer devices, technological innovative techniques emerged to alleviate some of the problems of lecture instructional technique but some teachers are ineffective in using them (Kim, 2016). Such innovative techniques include PowerPoint technique, 2D animation technique, multimedia technique, video conferencing technique, among others. Among these innovative techniques, 2D animation was explored by the researchers due to the dearth of literature on its impact on students' achievement in the Nigerian context.

Ejimonye*et al*. (2020) defined two dimensional (2D) Animation technique is a type of technique that could attractively facilitatelearning by engaging the students during the teaching and learning process. It is the art of creating movement in a two-dimensional space (Fitzgerald, 2018). Operationally, 2D animation is a design that deals with the movement of an inanimate object, diagram or image in an x and y environment to transfer knowledge to the learners. 2D animation is the art of creating movement in a two-dimensional space. 2D animation is based on x-axis and y-axis and the justification of 2D animation in this study is that it is suitable for graphical presentations. 2D animation is more like a cartoon and parents use it to educate

theirchildren at home. 2D animation is designed by moving pictures within a two-dimensional environment and it works when consecutive images (or "frames) simulate motion because of slight alterations to each image. The quality of education can be leveraged with the inclusion of animations in classroom teaching (MAP, n.d). Benefits of animation in education are well-known. Any concept can be presented in a lively and visually engaging manner. It is scientifically proved that a process dynamically illustrated can be retained in memory for longer duration compared to oral memorizing. Further, animated educational videos would take boredom away from learning. The limited attention span or lack of concentration from which most students suffer can be overcome. If you observe the habits of children critically, you will find that they take great delight in watching and sharing memes, videos on social sites, gifs etc. This implies that animated content leaves a deep-rooted impression on the malleable intellect of children.

MAP (n.d) identified the importance of animation for children can be seen in the educational field also. In classrooms, animated learning material can be leveraged for a variety of purposes, like Explaining complex and challenging concepts in an easy to comprehend manner, Making learning a more enjoyable experience for even poorly performing students and presenting things in completely new perspectives. The role of animation in promoting interest for learning in students is paramount. It is imperative that parents and other stakeholders should champion the cause of including animation in learning. LinkedIn (2020) noted that animated learning modules enhance the innate creativity quotient in learners during the growing phase. Their interest in learning is ignited with exciting and interesting animated study modules. Complex topics of science, geography, and other subjects can be articulated easily. Assignments become easier for

students. After school programs can be organized effectively. The concentration of students becomes intense. Learning becomes fun.

Kwasu (2015) observed that certain concepts are more complex and often require focused teaching efforts to provide clarity to students. 2D animated subject videos can be deployed to provide in-depth information and explanation about such concepts. Multimedia elements like audio, video, texts, images, and gestures can be blended together intelligently and coherently to make complex subjects more comprehensible. Students with various IQ levels too can exhibit exemplary understanding. With animations, concepts that baffle understanding can be easily articulated. Such inscrutable concepts can be defined at length using interesting multimedia presentations. This helps learners to visualize the concepts in a better manner. The imagination of young minds can be taken on a flight using comprehensive and agile animation learning modules. Traditional classrooms are confined to brick-and-mortar rooms. Children have to attend the classes for fixed durations irrespective of whether they could understand the topics discussed or not. With animated modules, lessons can be published as online podcasts which help children to learn at their own pace even out of classes. Interactive lessons can be learnt from different locations. All subjects can be included. Access to resources can be gained even from home and library. This offers an added incentive or encouragement for learning and consistent improvement. Animations can be integrated with soothing background music which can calm the mind, improve concentration, and facilitate optimum comprehension.

With animated e-learning modules, learners of various age groups can benefit from intuitive studies. Different approaches can be adopted for children of kindergarten, secondary, higher secondary and university learners (Reimers, 2020). The exciting and perky animations would prove to be appealing for all irrespective of age. Efficiency of learning and productivity can be

improved by teachers who would adopt diverse approaches for learners of different age clusters. Certain approaches can be retained for all. Animation education allows children to keep in memory concepts learnt in previous classes or sessions also. Animated sequences can be presented with gripping narratives, complementing audio effects, and soothing music. These add more power to e-learning courses. Different sensory perceptions in children are triggered and parts of the brain responsible for retention are actuated. Learning material would not only engage the viewers but would also stimulate their memories. Often children feel shy or self-conscious in expressing their feelings. The presence of students, who score better marks, around them also inhibit their creative energies. Stuckey (2010) observed that traditional art forms such as painting or drawing are not everyone's cup of tea. They may appear fun to learn but for those who suffer from intrinsic artistic flair for these art forms can feel depressed.

Such problems can be vaulted over with the help of animation in education. Characters are already crafted and supplied in environments which are illustrated beforehand. The innate creativity of learners can be sustained and inspired through pre-built animated modules like speech bubbles. Many companies are launching animated study materials that are solely developed for usage in schools and come accompanied with class management features for teachers (MAP, n.d). Animated videos enhance the communication skills of learners. They learn to imitate and mimic the peculiar ways of objects depicted through animation. Learners' confidence in facing others for delivering their ideas in a compelling manner grows. With animation videos, proper grammatical and sentence formation methods can be spelled out. This improves the linguistic skills of learners significantly. Students who are subjected to such animation videos often exhibit advanced grammatical and language proficiency compared to their peers with no exposure to animation.

NextThought (2017) noted that the importance of animation for educational purposes can be understood from the fact that learners can move to the next stage of education seamlessly. This is because animations demonstrate the concepts from a practical perspective which makes understanding easier. Also, students are motivated to research things more thoroughly. Learners are encouraged to optimally use their senses of seeing, touching, smelling, hearing and tasting. As students gain prior knowledge of their interest areas, their research instincts become more incisive Davis (2020). Students' technical awareness of learning disciplines which are more practical in nature becomes more focused. Example of such a technical domain is measurement related segment where different objects' areas, volumes or lengths have to be estimated. Students can learn geometrical concepts easily. Consequently, they become competent in solving various problems by applying technical skills. This results in improvement in overall performance and better scores in various assessments. Students become proficient in imitating animation objects and grow in confidence after being exposed to learning videos. Normal classroom teaching is complemented by animation videos that depict the correct way of expressing things. The experience acquired by mimicking animation videos helps improve students' presentation and articulation skills. Students also interact more confidently and smartly with peers in the classroom (Ngonyani, 2018).

Video animations can be used for presenting cryptic information to learners. Specific objects or words are suggested through which a learner is encouraged to interpret the information encrypted. This would motivate the learners to leverage their critical thinking skills for interpreting the information. During execution of ideas in a practical manner, the critical interpretation skills of learners shine forth.

Through class demonstrations, animation videos serve to cultivate the skills of learners in alignment with their future academic specializations. The use of animation in teaching leads to the development of technical skills which prove useful while pursuing engineering or other technology-oriented courses. Students also become conversant with the careful handling of different measurement tools. Learners can gain vital information about their desired careers during class presentations. Learners attending K-2 classrooms have immersive studying experience due to animated courses. Kids start relating with fictional characters in cartoons and books. This connection with characters allows them to relate with adults and peers in a more meaningful manner. Animated 3D characters nurture specific habits in students which helps in refining their critical thinking ability and social skills. This fosters healthier interactions with others for the complete lifetime of learners.

Compassion, kindness and empathy can be nurtured in young learners effectively through animated characters which set an ideal before them. As kids love to emulate characters, the animations have a positive impact on cultivating their social skills. Multi-sensory techniques are used as effective interventions for various professional development programs. Animation can serve as an effective multi-sensory tool. Learners can view how their favorite characters behave in difficult situations, listen to their responses, observe their interactions with other characters, and share these experiences with teachers and peers. The ‘Habits of Mind’ animations’ website carry extension lessons in printable format which can also involve the tactile sense. Critical thinking can be easily taught to learners with animation.

Children have a natural tendency to imitate animated characters they come across. These can be game characters who may be violent or aggressive. To shield children from acquiring undesirable traits, it is important to subject them to animated videos whose characters have

refined social skills. This would help kids learn good skills which will make them evolve as enlightened beings. You can convey complex information in an impactful manner with short animation videos. The tone, expression and body language of characters help children understand the environment in which particular appearance, style and interaction mode is suited. Children learn how to react to good and bad things and can develop the skill to predict. Shared experiences can be provided to learners in the classroom with animated learning videos. Written or verbal communication can be promoted by offering something to collectively ponder over. Social traits can be acquired by children quickly by watching the same in practice in group mode. Engaging animation fuels imagination leading to better communication and nurturing of new ideas. Constructive debating is promoted. Animation videos give a sense of inclusion for all students in the learning process. The enrichment students gain with shared viewing is reflected in their writing and verbal skills.

Paulinus*et al.* (2016) revealed that animation has been proven by numerous studies as a medium conducive to facilitate optimum learning in students. However, courses have to be comprehensively, holistically and strategically designed to ensure that desired outcomes are achieved. Animation can be put to various creative uses for complementing different segments. It is useful for accomplishing desired objectives in a streamlined manner. In the educational sector, animation is a potential tool for driving ease of comprehension (Kwasu, 2015). We can develop and deliver compelling and stimulating learning modules integrating 2D animations and 3D animations along with supportive multimedia elements for taking teaching pursuit to the next level. The lesson architectures can motivate learners and promote their potential.

2.1.8 Interest

From the psychological point of view, interest can be classified as individual interest and situational interest. Individual interest has a dispositional quality residing in the person across situation (Harackiewicz et al., 2016). In contrast, situational interest emerges in response to features in the environment. Hidi and Renninger further explained that situational interest (SI) can be differentiated into triggered-SI and maintained-SI. Triggered-SI involves heightening the effective experiences individuals associate with the environment. It involves arousing an individual's interest. MaintainedSI is a more involved, deeper form of situational interest in which individuals begin to forge a meaningful connection with the content of the material and realise its deeper significance. Interest is the tendency of an individual to react positively towards an object, situation or value. One's interest can easily be determined by his behavior. Every individual has values, which when expressed show the kind of interest the individual has. Okpala (2021) defined interest as a powerful source of human motivation which is capable of arousing and sustaining concentrated effort. It is a disposition that prompts an individual to spontaneous action. Jhangiani (2021) stated that interest is a response to liking or disliking of an activity, object, or a person. It is the degree of likeness an individual has for something. It is the preference of a person to a particular type of activity to the other. Cook and Artino(2016) also described interest as an internal state that influences the individual personal actions. Liu (2014) argued that interest and motivation are components of attitude which can be influence by reinforcement; meaning that reinforcement or incentive can arouse interest of an individual to participate in certain kinds of activities. Conversely, negative reinforcement can inhibit one's interest to participate in an activity which may result into a dislike to an activity. Rowland *et al.,* (2019) stated that interest is a differential likelihood of invested energy in one set of stimuli over the other. The ability to arouse students interest in science plays an important role in improving

existing curriculum to meet their needs. The researcher defines interest as an innate drive that prompts an individual to action.

2.2 Theoretical Framework

2.2.1 Constructivist theory

Constructivist theory of learning, based on the ideology that information or concept is created by the learner on the basis of mental activity. Constructivists claim that learners construct their own truth, or at least perceive it on the basis of their perceptions and experiences, so that individual knowledge is a feature of one's previous experiences, mental constructs, and beliefs that are used to interpret objects and events (Adom*et al.*, 2016). The theory is credited to Bruner in 1960 and Piaget in 1980, who argued that knowledge is internalized by the learner through the course of accommodation and assimilation. Bruner stated that learners construct new ideas or concepts based upon existing knowledge and that learning is an active process. The process includes selection and transformation of information and making meaning from information and experiences. Bruner also informed that it is possible to structure knowledge in a way that enables the learner to most readily grasp the information and that instruction should relate to learners 'predisposition and facilitate interest toward learning. Piaget stated that knowledge is not information to be delivered at one end and encoded, memorized, retrieved and applied at the other end. Instead, knowledge is experience that is acquired through interaction with the world, people and things. Piaget is of the view that humans must construct their own knowledge building it through experience. Experiences, it was further stated, enables them to create schemas - mental models in their heads, which are subsequently enlarged, and made more sophisticated through the processes of assimilation and accommodation. According to Ultanir (2012), knowledge is constructed from experience and learning is a personal interpretation of the world.

It is an active process in which meaning is developed on the basis of experience and conceptual growth comes from the negotiation of meaning, the sharing of multiple perspectives and the changing of our internal representations through collaborative learning. Constructivists believe that learning occurs when it is situated, contextual, problem based, social and authentic. This position was also echoed by Igwekanne (2017) who stated that with the constructivist model of instruction, students redefine, reorganize, elaborate and change their initial concepts through interaction among themselves and their environment.

2.2.2 Visual Auditory Read/Write kinesthetic learning theory (VARK)

Visual Auditory Kinesthetic Learning Theory (VARK) proposed by Fleming in 1995. According to Fleming, information should be conveyed using three styles: visual learner, auditory learner, read/write, and kinesthetic learner. Fleming argues that the use of VARK in pedagogy helps teachers to prepare students for any of the four areas. Fleming suggested that the more a student is able to learn through a combination of all modalities, such as visual and auditory, the more integrated learning will be. Visual auditory Read/Write kinesthetic (VARK) theory suggests that visual learners should be encouraged to among others: visualize spelling of words or facts to be memorized and that of auditory learners should be encouraged to use verbal analogies as storytelling to demonstrate their points. To this effect, VARK theory is suitable for this study because when audio visual materials are used during teaching and learning, the students will visualize spellings of words, memorize facts and use analogies and storytelling to demonstrate their points. This study will authenticator refute VARK.

2.3 Empirical Studies

Several research studies have been carried out to investigate the impact of infographics on students' academic achievement and retention, some of these empirical studies include those of

Untari*et al.* (2020) developed interactive multimedia and assess the effectiveness of its application in Project-Based Learning (PjBL) for 2D animation making. The researchers applied the Research and Development method using the 4D model. This study was conducted at the UniversitasMuhammadiyahSidoarjo, with a total of 66 students of Information Technology Education. Based on the results of the study, validation by material and media experts showed that interactive multimedia learning media is excellent and feasible to use. The effectiveness of the application of interactive multimedia in PjBL has a significant positive effect on learning achievement for making 2D animations.

Allela (2013) sought to develop an educational animation targeted at children ages 7-11, to evaluate its effectiveness in supporting teaching and learning of Mathematics. It was presumed that such animation can develop learners' skills and competencies in understanding mathematics-based problems through; storytelling, visual communication, cognition, emotion, observation and problem solving when the medium of instruction appeals to them and is both socially and culturally meaningful. According to Piagetian theories on cognitive development, children at this stage are at a 'Concrete Operational Stage', during which they learn better when more of their senses (seeing, hearing, touching, smelling and tasting) are being triggered. In the experimental design, three measures were used to evaluate the effectiveness of the animation. They include comprehension, enjoyment assessment and socially contingent behavior. 120 children from two public and one private junior secondary school participated in the study and were all exposed to the treatment variable after which, each was provided with a questionnaire that sought to measure their levels of compression and skill acquisition. An analysis of the ensuing data revealed that there was a statistically significant difference between the mean scores of the

baseline and the post-test results at 95.0% confidence level. This therefore implies that students were able to learn from the animation.

Islam *et al.* (2014) developed visual learning materials (an overview of solar system) in the form of video for students of primary level using different multimedia application tools. The objective of this paper is to examine the impact of a student's abilities to acquire new knowledge or skills through visual learning materials and blended learning, that is integration of visual learning materials with teacher's instructions. We visited a junior secondary school in Dhaka city for this study and conducted teaching with three different groups of students (i) teacher taught students by traditional system on same materials and marked level of student's ability to adapt by a set of questions (ii) another group was taught with only visual learning material and assessment was done with 15 questionnaires, (iii) the third group was taught with the video of solar system combined with teacher's instructions and assessed with the same questionnaires. This integration of visual materials (solar system) with verbal instructions is a blended approach of learning. The interactive blended approach greatly promoted students' ability of acquisition of knowledge and skills. Students' response and perception were very positive towards the blended technique than the other two methods. This interactive blending learning system may be an appropriate method especially for school children.

Zaobi*et al*. (2012) developed computer animation in order to depict the dynamic processes in Bipolar Junction Transistor and compares the academic achievements of students who learned BJT via animation to those who learned via static diagrams. 41 students were randomly divided into two groups, 21 students in the experimental group and 20 students in the control group. The experimental group received explanations including animation while the control group received traditional explanations using a blackboard but no animation. A comparison was made between

the students' achievements in both groups via a pretest. After learning about BJT, a posttest and new comparison was conducted. The comparison referred to two categories: A. Total score on the test; B. Score on questions that require higher level of thinking. The pretest results showed no significant difference between the groups' achievement. In contrast the results of the posttest were significant, showing a 12-point advantage in the average total score, and about a 14-point advantage in the average on higher level thinking questions in the experimental group as opposed to the control group.

Numgwo *et al*. (2017) determined effects of animation on students' achievement and retention in Basic Electricity at Technical Colleges in Benue State, Nigeria. The study adopted quasi-experimental research design, specifically the pre-test post-test non-equivalent control group experimental design. Students' performance was obtained after being treated with animation instructional technique and conventional teaching method. There was no sampling as the population of the study consisted of all 82 Technical college one (TC 1) students offering Basic Electricity. The instrument used was Basic Electricity Achievement and Retention Test (BEART). Reliability testing of BEART was carried out with the use of test-retest technique and a reliability coefficient of 0.81 was obtained. Data collected were analyzed using mean and ANCOVA at .05 level of significance. The findings of the study revealed that students taught with animation have higher achievement and retention in Basic Electricity than with conventional methods. The findings imply that animation had a positive effect on students' understanding of Basic Electricity. It is recommended that technical college teachers be equipped with necessary skills required to employ animation in teaching.

Barut&Dursun et al. (2022) developed and validated the Instructional Material Motivation Scale for Single-Use (IMMS-SU) instrument in the Turkish context. The IMMS-SU was developed

and validated in a two-phased process on a sample of 1654 students. The Exploratory Factor Analysis revealed that IMMS-SU included 14 items ($\chi 2 = 332.59$; $sd = 74$; $p < 0.001$), the fitness indices were found to be RMSEA = .077; SRMR = .040; AGFI = .88; NFI = .95; CFI = .96; and GFI = .92. The Cronbach's Alpha coefficients regarding the whole scale was calculated as $\alpha = 0.95$. Thereafter, in the second study, the animated and interactive video materials used in distance education were scrutinized in the context of openness to different materials, time spent viewing, motivation, and cognitive load. A total of 933 students participated who had a distance education experience. In order to collect data, the extraneous cognitive load instrument and questionnaire items were used. According to the findings, it was determined that animation and interactive video materials did not cause a higher level of cognitive load on the participants, and both groups had higher material motivation. In addition, it was revealed that interactive video materials caused a higher extraneous cognitive load in participants than animation group. It was figured out that as the openness levels of the participants watching the animation and interactive materials decreased, their cognitive load levels increased. In the light of the results, some suggestions have been recommended for further research.

Chikendu (2018) investigated the effect of instructional computer animation on secondary school student's achievement and interest in chemistry in Awka Education Zone. The reason for the study is that there is a general poor achievement of student's in secondary school certificate chemistry examinations. The purpose of the study was to determine the effect of the use of instructional computer animation on student's achievement and interest in chemistry. Four research questions guided the study, and six null hypotheses were tested. The study adopted a quasi-experimental design specifically, pretest-posttest non-equivalent control group design. Population of the study consisted of all the 2927 Senior Secondary Year Two chemistry students

in the 61state owned secondary schools in Awka Educational Zone. The sample consisted of 186 students drawn from two coeducational secondary schools out of the 46 co-educational secondary schools in Awka Education Zone. One of the schools was randomly assigned to experimental group while the other was assigned to control group. Chemistry Achievement Test (CAT) and Chemistry Interest Scale (CIS) were the instruments used to collect data for the study. The CAT of 25 items and CIS of 17 items were trial tested on an intact class of 40 students outside the study area. The reliability coefficient of CAT was established to be 0.72 using Kuder Richardson (KR-20) while reliability coefficient of CIS was established to be 0.78 using Cronbach alpha. The CAT and the CIS were administered to the students as pretest and posttest for data collection. Mean and standard deviation were used to answer the research questions while Analysis of Covariance was used to test the null hypotheses at 0.05 level of significance. The result revealed that instructional computer animation had significant effect on student's achievement and interest in chemistry. Female students performed better than the male students taught using instructional computer animation. This implies that instructional computer animation enhances students' achievement and interest in chemistry. Based on the results of the study, it was recommended that instructional computer animation be adopted by chemistry teachers for teaching chemistry concepts to secondary school students. Curriculum planners should incorporate and emphasize the use of instructional computer animation as an alternative to conventional method.

Aiyedun (2020) examined the effect of animation teaching strategy on secondary school students' achievement, retention and interest in climate change in Lokoja, Kogi State. Three objectives and three research questions were raised and answered, and three null hypotheses were tested. A non-randomized pretest post-test quasi-experimental design was adopted for the

study. The population covered all public Senior Secondary School, year three (SSS 3) science students in Lokoja, Kogi State. Two intact classes which are made up of one hundred and thirty (130) students were sampled. The instruments for data collection are Environmental Education Concept Achievement Test (EECAT), Environmental Education Concept Retention Test (EECRT) and Environmental Education Concept Interest Scale (EECAS) respectively. Statistical tools used include percentages, mean ($\overline{x}$) and standard deviations to answer the research questions while Analysis of Covariance (ANCOVA) was used to analyze the research hypotheses at a significance level 0.05 (5%). Findings of the study revealed that animation teaching was viable in upgrading students' achievement, retention and interest in climate change. The paper recommended among others that teachers should teach Environmental Education infused concepts with animations.

Ezeugwu et al., (2016) examined the influence of cognitive ability, gender and school location on students' achievement in senior secondary school financial accounting in Owerri Education Zone 1 of Imo state. The study was motivated by poor achievement of students in financial accounting in the study area. To carry out the study, a causal comparative design was used. A total of 284 senior secondary school students offering financial accounting in 2011/2012 academic session drawn from government owned schools in the zone participated in the study. Financial accounting achievement test (FAAT) and test of logical thinking (TOLT) were used as instruments for data collection. The validity and reliability of the instrument were established. The FAAT had a reliability index of 0.91while TOLT had 0.81. Six research questions and six hypotheses guided the study. The research questions were answered using mean and standard deviations while the hypotheses were tested using analysis of variance. The findings of the study revealed a higher and statistically significant difference in the achievement of male and female

students in favored male students; a higher but not statistically difference in the achievement mean score of rural and urban students while there was a significant difference in the achievement mean scores of high, medium, and low ability students in favor of high ability students. The test of interaction indicated that there was interaction effect of gender and school location, gender and cognitive ability, and school location and cognitive ability on achievement of students in financial accounting. Based on the findings, a number of recommendations were made which include that Financial Accounting teachers should pay attention to the issue of gender differences in classroom instruction, professional association like accounting teachers association should organize periodic training sessions in the form of workshops or seminars for accounting teachers on the use of teaching methods and learning resources that is not gender bias to improve classroom teaching and learning and government through the ministry of education should ensure that learning facilities, human and materials, teaching and non-teaching staff should be equal in schools located in the urban and rural areas since graduate of this school will compete in the same environment in terms of admission into higher institution, labor market and other activities.

2.4 Summary of the Literature Reviewed

The literature reviewed revealed the nature and scope of mathematics, mathematics curriculum in Nigeria. Methods of teaching mathematics, concept of instructional materials, classification of instructional materials, what are 2D animation and the use of 2D animation to teach. The researcher identified two theories relevant to the study, these are the; constructivist theory and the Visual Auditory Read/Write kinesthetic learning theory (VARK); these theories helped build up the theoretical framework of the study. The empirical studies also revealed that 2D animations had a significant effect on academic achievement.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Research Design

The researcher used the quasi-experimental design, specifically the pretest, posttest, non-equivalent control group design was used. This implies that intact classes (non-randomized groups) participated in the study. The quasi-experimental design is therefore considered appropriate for this study since intact classes were used.

3.3 Population of the Study

The population for this study consists of all the mathematics students in Gurara, Niger state with a total population of (3170) students which constitute the population of the study Niger State Universal Basic Education Board (NSUBEB) while the target population comprises of primary five (5) mathematics students in Gurara, Niger State.

3.4 Sample and Sampling Technique

A sample refers to a small group of elements drawn through a definite process from a specific population. A sample size of eighty-four students was drawn from the two schools. To produce the sample, intact classes were employed as the students were sampled as they were found in their classrooms; primary five (5) A from the two purposively selected schools, balloting was used to represent the experimental and control groups. The sample for the experimental group of one of the selected schools was used as an experimental group and the other served as the control group. Primary five (5) **A** of Model Nursery and Junior secondary school GawuBabaginda with a class population size of forty-one students formed the experimental group while Primary five (5) **A** of Bunmajnursery, primary and secondary school GawuBabaginda, Niger State with a class population of forty-three students formed the control group.

Table 3.1: Sample Size

S/N	Name of School	Population	Male	Female	Total
1	Model Nursery and Junior secondary school GawuBabaginda	41	30	11	**41**
2	Bunmaj nursery, primary and secondary school GawuBabaginda, Niger State	43	34	9	**43**
Total		**84**	**64**	**20**	**84**

The experimental group were taught using the 2D animation package and the control group were taught using conventional methods.

3.5 Research Instrument

Anadopted 2D animation video was used as the treatment instrument, while the researcher constructed a Test of Logical Thinking (TOLT) was used to assess students' cognitive ability in mathematics while a checklist was developed by the researcher titled "2D animation and Interest Checklist (2IC)".was used for data collection. The instrument was constructed by the researcher, and it consists of ten (10) questions on Geometry. The cognitive test consists of multiple-choice questions with four (4) options (A-D) out of which one serves as the correct answer based on the topic taught (Geometry). However, at the second face (posttest) the options were interchanged likewise the numbering method (reshuffled). Each score per correct answer is one (1) mark. The objective of the topic in the junior secondary school mathematics curriculum served as a guide for developing the questions. The items in the Test of Logical Thinking (TOLT) were constructed and tested by the researcher to ensure the inclusion of all the contents of the lessons covered in the topic. The Test of Logical Thinking (TOLT) was used to assess the students' cognitive ability in Mathematics.

The 2D animation and Interest Checklist (2IC) was made up of two sections, the first section elicit responses based on the biographical data of the respondents such as gender of the pupil while the second section collected responses based on the interest level of the respondent which was divided into three (3) separate levels; high, medium and low. These levels indicated the pupil's level of interest towards the use of 2D animation for teaching and learning of mathematics in junior secondary school.

3.6Validity of Research Instrument

The Test of Logical Thinking (TOLT), which consists of ten (10) multiple choice questions was face and content validated by two experts, one (1) expert from the Department of Educational Technology, School of Science and Technology Education (SSTE), Federal University of Technology Minna and a subject expert from FUT Staff school. The second instrument for data collection; 2D animation and Interest Checklist (2IC) were also validated by two experts, two (2) experts from the Department of Educational Technology, School of Science and Technology Education (SSTE), Federal University of Technology Minna. Meanwhile, the 2D animation video was validated and criticized by two experts in the department of Educational Technology. These experts scrutinized the instruments and made necessary corrections and modifications to the subject, proper wording of the items, appropriateness and adequacy of the items for the study, structure and adequate timing. The comments and recommendations of these experts helped to identify and correct the items in the instruments.

3.7 Reliability of the Research Instrument

To determine the reliability of the Test of Logical Thinking (TOLT) and 2D Animation and Interest Checklist (2IC), a pilot test was conducted on 20 junior secondary school mathematics students who had received instruction with the 2D animation package at FUT Staff School in Bosso, Niger State. The school was not one of the sampled schools for the study. To obtain a reliability index for the TOLT, the Kuder Richardson reliability coefficient was utilized, and a coefficient of 0.89 was determined from the data using Kuder Richardson 21. This coefficient indicates that the TOLT was a reliable instrument for the study, meaning that it produced consistent results over time. Similarly, to determine the reliability of the 2D Animation and Interest Checklist (2IC), the Cronbach alpha was used for reliability testing, and a reliability index score of 0.78 was obtained. This score indicates that the 2IC was also a reliable instrument for the study, meaning that it produced consistent results over time. In conclusion, the pilot test conducted on the 20 junior secondary school mathematics students who received instruction with the 2D animation package at FUT Staff School in Bosso, Niger State, showed that both the TOLT and 2IC were reliable instruments for the study. Therefore, the researchers could confidently use these instruments to collect data in their study.

3.8 Method of data collection

The school selected was visited by the researcher. Permission was taken from the Headmaster of the school which was given. The researcher was introduced to the Mathematics teacher of primary five (5) students. The aim and mode of research was explained to both the teachers and the students for their maximum cooperation. Thereafter, the students were sampled; the students were sampled from the two (2) schools; a pretest was administered to the students in order to assess their entry behavior. The test was administered to the two schools used for experimental and control groups in the first week of the visit to the schools. The Test of Logical Thinking

(TOLT) consists of 10 test questions which were drawn from the topic “Geometry” in accordance with the Junior secondary school mathematics curriculum. Each question is followed by four multiple-choice optional answers (A-D) and students were expected to choose the correct answer. Each correct answer chosen earns one mark, zero awarded to any wrong answer chosen and overall score is then converted to percentage. The test lasted for thirty (30) minutes, the lesson commenced in all groups in the second week of experiment which was conducted using the regular period allocated to Mathematics during class hours. The experiment continued for two (2) weeks followed by revision. The two (2) schools were taught Mathematics for this period of two weeks. The experimental group was taught with the 2D animation package while the control group was taught without the 2D animation package. In the fourth week, posttest was administered to the two schools to test the cognitive ability of the students for both experimental and control groups. The same items contained in the pre-test were used but this time around the questions numbering were reshuffled as well as the options. Each correct answer chosen earns one mark, zero was awarded to any wrong answer chosen and the overall score is then converted to percentage. The test lasted for 30 minutes and scripts were collected immediately for scoring. The experimental group were also administered with the 2D animation and Interest Checklist (2IC) to assess the interest level of the students towards 2D animation.

3.9 Method of Data Analysis

In order to answer the research questions, a combination of statistical methods was employed, including the use of percentages, mean and standard deviation. Additionally, the independent sample t-test was utilized to test the hypotheses, with a significance level of 0.05 chosen as the threshold for acceptance or rejection of each hypothesis. The outcomes of this analysis will be used to arrive at findings, discussions and a summary of the results. To conduct this analysis, the

Statistical Package for Social Science (SPSS) version 23.00 was utilized as the computer software of choice.

CHAPTER FOUR

4.0RESULT AND DISCUSSION

4.1 Result

In this chapter, data for the study were analyzed and presented based on the research questions and hypotheses that guided the study. The research questions were answered using mean and standard deviation while independent statistics was used to test the research hypotheses. All the hypotheses were tested at $P < 0.05$ level of significance.

Research Question One: Development of 2D animations

The researcher adopted the use of a 2D animation video from YouTube, the animated video was selected after a series of query and selection process that made the use of critical judgement to ensure that the animation was suitable for junior secondary school students. The URL for the animated video https://youtu.be/d-FeQpT0OAg the video was displayed to the experimental group with the aid of a television.

Figure 1 Animated Video/YouTube.com

Table 4.1.1 t-test analysis of pre-test scores of students in the experimental and control group

Group	N	df	$\bar{x}$	SD	t-value	p-value	Decision
Experimental group	41		4.31	0.64			
		82			-0.22	0.82	NS
Control group	43		4.34	0.65			

NS=Not Significant at P>0.05

Table 4.1.1 shows the t-test analysis of pretest scores of students in the experimental and control group, with a p-value of 0.82 at p>0.05. this implies that there is no significant difference in the pretest scores of students before the treatment.

Research Question Two: What is the mean cognitive score of junior secondary school students taught using 2D animation and those taught without 2D animation? The answer is shown below on table 4.2.

Table 4.2 Mean and Standard Deviation of posttest scores of students in the experimental and control group

Group	N	Posttest	
		x	SD
Experimental	41	8.56	1.07
Control	43	5.25	1.21

Table 4.2 indicates that students taught Mathematics using 2D animation package has a mean cognitive score of 8.56 with a standard deviation of 1.07 at the posttest while those taught using the conventional method had a mean cognitive score of 5.25 and a standard deviation of 1.21. from the posttest mean scores, it is revealed that the students that were taught with the 2D animation package scored higher than those taught using traditional method.

Research Question 3: What are the gender differences of 2D animation on cognitive ability of students in junior secondary schools? The answer is revealed in Table 4.4

Table 4.3 Mean and Standard Deviation of male and female cognitive scores of students in the experimental group

Group	N	Posttest	
		x	SD
Male	30	8.46	1.19
Female	11	8.81	0.60

Table 4.3 reveals the influence of gender on the mean cognitive scores of students taught using the 2D animation package. The male students had a mean cognitive score of 8.46 and a standard deviation of 1.19 at the posttest, the female students had a mean cognitive score of 8.81 and a standard deviation of 0.60. This indicates that females performed higher than their male counterparts.

Research Question 4: What is the level of interest of students taught using 2D animation?

Table 4.4 Interest level of students taught using 2D animation.

Interest	Frequency	Percent
Low	6	14.6
Medium	13	31.7
High	22	53.7
Total	41	100.0

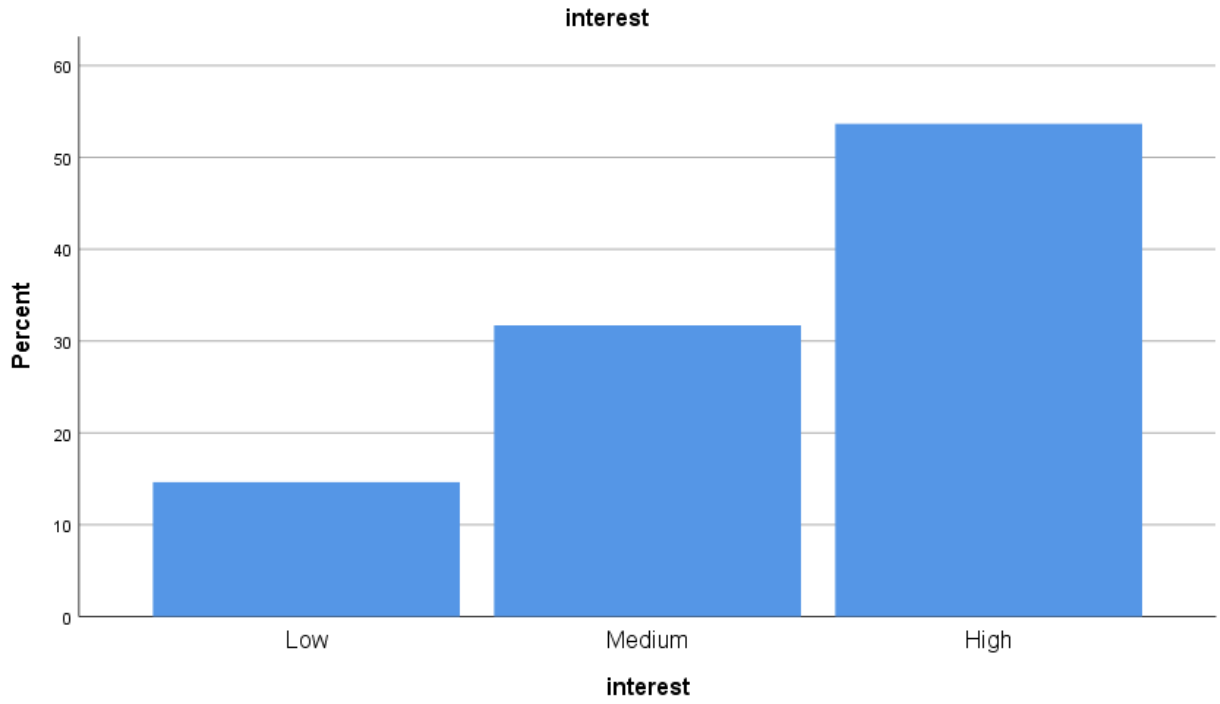

Figure 4.2 Interest level of students taught with 2D animations.

Table 4.4 reveals that the interest level of the students was high, with a total of 53.7%, while medium and low stood levels stood at 31.7% and 14.6% respectively based on the responses gathered from the study.

4.2 Hypothesis Testing

HO_1: There is no significant difference between the mean cognitive score of Mathematicsstudents taught using 2D animation and those taught without 2D animation.

Table 4.5 T-test for the posttest cognitive scores of the experimental and control groups

Group	N	df	$\bar{x}$	SD	t-value	p-value
Experimental group	41		8.56	1.07		
		82			13.21	0.00
Control group	43		5.25	1.21		

Significant at $p < 0.05$

Table 4.5 shows the t-test analysis of students taught Mathematics using the 2D animation package and those taught using convention method. The result revealed that t-value is 13.21 and p-value of 0.00 < 0.05. Therefore, the null hypothesis was rejected, this indicated that there is a significant difference in the mean cognitive test of students taught using 2D animation and those without it.

Hypothesis 2: There is no significant gender difference in the mean cognitive score of Mathematicsstudents taught using 2D animation and those taught without 2D animation.

Table 4.6 T-test analysis of male and female students taught Mathematics using 2D animationpackage.

Gender	N	Df	$\bar{x}$	SD	t-value	p-value	Decision
Male	30		8.46	1.19			
		39			-1.23	0.22	NS
Female	11		8.81	0.60			

NS= Not Significant at p > 0.05 level

The t-test for table 4.6 shows the mean cognitive scores of male and female students taught Mathematics using the 2D animation package. There was no significant difference between the mean cognitive scores of male and female students taught Mathematics using 2D animation package as determined by the t-test analysis with a t-value at -1.23 and a p-value of 0.22> 0.05. Male students ($\bar{x}$=8.46, S.D=1.19) while the female students ($\bar{x}$=8.81, SD=0.60). Therefore, the null hypothesis was not rejected, this revealed that there was no significant difference between the mean cognitive scores of male and female students taught Mathematics using 2D animation.

Hypothesis 3: There is no significant difference between male and female students based on their interest level towards 2D animation.

Table 4.7 T-test analysis of male and female students interest level taught Mathematics using 2D animationpackage.

Gender	N	df	$\bar{x}$	SD	t-value	p-value	Decision
Male	30		2.53	0.73			
		39			2.14	0.03	S
Female	11		2.00	0.63			

S= Significant at $p < 0.05$ level

The t-test for table 4.7 shows the male and female students interest level taught Mathematics using 2D animationpackage. There was a significant difference between male and female students based on their interest level towards 2D animation as determined by the t-test analysis with a t-value at 2.14 and a p-value of 0.03< 0.05. Male students ($\bar{x}$=2.53, S.D=0.73) while the female students ($\bar{x}$=2.00, SD=0.63). Therefore, the null hypothesis wasrejected, this revealed that there was a significant difference between male and female students based on their interest level towards 2D animation.

4.5 Discussion of Findings

The data analyzed in this chapter were interpreted and discussed on the results derived from four research questions and hypotheses. The main objective of the research is to determine the effect of 2D animation package on pupil's cognitive and retention in the teaching of Mathematics. The posttest scores in table 4.2 shows that the experimental group ($\bar{x}$=8.56, S.D=1.07) had a higher cognitive scores than the control group ($\bar{x}$=5.25, S.D=1.21). Similarly, the p-value associated with the calculated value of t.val (13.21) in table 4.6 is 0.00 which is less than the level of significance, the null hypothesis was therefore rejected. Hence, there is a significant difference in the mean cognitive scores of students taught Mathematics with the use of 2D animation package. The finding of this study is in line with the findings of Barut&Dursun et al. (2022) who revealed

the use of 2D animation package therefore has a significant effect on pupil'scognitive in Mathematics as compared to conventional teaching method.

The female students at posttest level ($\bar{x}$=8.81, SD=0.60) achieved higher than the male Mathematicsstudents ($\bar{x}$=8.46, S.D=1.19). Although, the p-value revealed there was no significant difference (p=0.87), in table 4.8 the p-value was greater than the 0.05 level of significance hence, the null hypothesis was accepted. The finding of this study is contrary to the findings of Chikendu (2018) who revealed that there is a significant difference in the achievement scores of male and female students.

The study further revealed that the students are highly interested in the use of 2D animation with a high percentage of 53.7% which shows that the respondents were interested in learning with the use of 2D animation. This finding is in line with the findings of Chikendu (2018); Aiyedun (2020) who revealed that students find 2D animation interesting. The hypothesis testing revealed that there was a significant difference between male and female students based on their interest level towards 2D animation as determined by the t-test analysis with a t-value at 2.14 and a p-value of 0.03< 0.05. Male students ($\bar{x}$=2.53, S.D=0.73) while the female students ($\bar{x}$=2.00, SD=0.63).

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The research is aimed at the development of 2D animation to improve the cognitive ability of junior secondary school students in Geometry. This chapter contains the summary, conclusion, recommendation, major findings of the study, contribution to knowledge, implications of the findings and suggestions for further studies.

5.2 Conclusion

Based on the findings and discussion of the study, the following conclusion were drawn;

The use of 2D animation package has been found to have a positive impact on the cognitive ability of Mathematics students. An experimental study showed that students who were taught using the 2D animation package demonstrated greater improvement in their cognitive abilities compared to those who were taught using conventional methods. This suggests that the use of 2D animation package can be an effective way to enhance students' understanding and retention of mathematical concepts.

In addition, the study also found that students who were taught mathematics using 2D animation showed a high level of interest in the subject. This indicates that students find 2D animations to be engaging and captivating, and as such, it is a useful tool for promoting interest in mathematics among students.

Based on these findings, it is recommended that emphasis should be placed on the use of 2D animation in teaching Mathematics, especially in junior secondary schools. By incorporating 2D animation into mathematics teaching, educators can create a more interactive and stimulating learning experience for students, which can help to improve their academic performance and overall engagement with the subject. Therefore, educators should encourage the use of 2D animation package in teaching and learning to enhance the cognitive abilities of students and promote their interest in mathematics.

5.3 **Recommendation**

In view of this project findings, the following recommendations was made;

1. In-service training should be organized for teachers so that they learn the process of producing 2D animation package and the use of modern instructional media for effective instructional delivery.
2. Seminars, conference and workshops should be organized and put in place for the teachers on the use of 2D animation package as instructional materials.
3. There should be adequate reinforcement to hardworking and dedicated teachers through prize awards as a means of appreciation.
4. Government, school administrators should show support and dedication to encourage creativity shown by co-science teachers by providing teaching materials which will promote science and technology in Nigeria.

5.4 Major Findings of the Study

The following findings have been made from the research work

1. There was significant difference between the mean cognitive scores of students taught Mathematics using 2D animation package and those taught using conventional method
2. There was significant difference between the mean retention scores of students taught Mathematics using 2D animation package and those taught using conventional method
3. There was no significant difference between the mean cognitive scores of male and female students taught Mathematics using 2D animation package.
4. There was no significant difference between the mean retention scores of male and female students taught Mathematics using 2D animation package.

5.5 Contribution to Knowledge

The result of the study has contributed to knowledge in the following ways

1. By assisting the teacher in comprehending the utilization of instructional materials and a 2D animation package, the abstract nature of Mathematical concepts can be decreased, thereby rendering learning more engrossing.
2. Sufficient employment of the 2D animation package will aid in the preservation of the teacher's time and energy.
3. The utilization of the 2D animation package can augment students' retention during learning activities.
4. It serves as a means of adding to the current body of literature and can be employed as a platform for subsequent research.

5.6 Implications of the Findings

Several teaching methods have been adopted over the years to improve cognitive levels of senior junior secondary school students in Mathematics. However, one of the most effective methods that has proven to be successful is the use of 2D animations.

This method has been found to be highly effective in teaching Mathematics, as it allows for greater interaction between students and learning content. The use of 2D animation creates a dynamic and engaging learning experience that captivates students and keeps them actively involved in the learning process. The visual aids and graphics used in the animations also help to simplify complex concepts, making them easier to understand and remember.

Moreover, the use of 2D animation enables students to learn individually and caters to a plethora of sense organs. This interactive approach to learning not only improves students' cognitive ability and interest levels of what they are being taught but also increases their confidence and motivation levels.

Therefore, it is essential for teachers to be encouraged and educated on the use of 2D animation package in teaching Mathematics. By integrating this method into their teaching approach, they can enhance their students' knowledge and understanding of Mathematics, as well as improve their overall academic performance. Additionally, this teaching method is suitable for different types of learners, including visual, auditory, and kinesthetic learners, making it a more inclusive and effective approach to teaching Mathematics.

5.7 **Suggestions for further Research**

Areas where further research could be done are as follows.

1. Effects of 2D animation on the academic achievement and retention of students on other subjects such as Chemistry, Physics, Mathematics among others.
2. Effect of 2D animation in teaching and its cognitive, retention and motivation on pupil’s performance

3. Effects of 2D animation on the cognitive and retention of Mathematicsstudents in North-central Nigeria.

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