EFFECTS OF VIRTUAL TECHNOLOGY TEACHING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' INTEREST AND ACHIEVEMENT IN MATHEMATICS IN FEDERAL CAPITAL TERRITORY ABUJA, NIGERIA

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AUGUST, 2026

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BEING A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF EDUCATION (M.ED.) DEGREE IN MATHEMATICS EDUCATION, DEPARTMENT OF SCIENCE AND ENVIRONMENTAL EDUCATION, FACULTY OF EDUCATION, UNIVERSITY OF ABUJA, ABUJA, NIGERIA

AUGUST, 2026

DECLARATION

I hereby declare that this work is the product of my research efforts; undertaken under the supervision of **Prof. U. S. Anaduaka** and **Prof. C. G. Ekpo,** and has not been presented and will not be presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

_____ _____

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CERTIFICATION

This is to certify that the research work for this dissertation titled "**Effects of Virtual Technology Teaching Strategy on Senior Secondary School Students' Interest and Achievement in Mathematics in FCT, Abuja, Nigeria"** and the subsequent preparation of the dissertation by **Ikyulavwase Timothy AZENDA with REG. NO.: 19/404SEEU/007** were carried out under our supervision.

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APPROVAL PAGE

This dissertation has been examined and approved for the award of Master of Education (M.Ed.) in Mathematics Education, by the Dissertation Examination Committee.

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DEDICATION

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ABSTRACT

This study examined the effects of virtual technology teaching strategy (VTTS) on senior secondary school students' interest and achievement in Mathematics in FCT Abuja, Nigeria. The study employed quasi-experimental research design adopting pretest and posttest control group. The population for this study comprised 9,887 SS II students with sample of 120 SSII Students. The schools were selected using simple random sampling technique. Two instruments were constructed for the study. These were: Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) which were validated by experts and the reliability yielded 0.79 and 0.84 using Kuder-Richardson 21 formula and Cronbach Alpha respectively. Data collected were analyzed using mean rank, mean and standard deviation to answer the research questions while Mann-Whitney U test and ANCOVA were used to test the null hypotheses at 0.05 level of significance. The findings revealed that there was statistically significant difference between the mean interest and achievement scores of students taught Mathematics using VTTS and those taught using conventional teaching method in favour of the experimental group. However, there were no significant difference between male and female students' mean interest and achievement scores in the experimental group. Based on the findings, it was amongst others recommended that Virtual Technology Teaching Strategy (VTTS) be adopted by the teachers as it appeared to have a positive effect on students' interest compared to conventional teaching method. Teachers should adopt and integrate the virtual technology teaching strategy more widely in Mathematics classes to improve students' achievement. Mathematics educators should continue using the virtual technology teaching strategy since it engages both male and female students equally, promoting gender-inclusive learning. Stakeholders in education should encourage teachers on the use of virtual technology teaching strategy as an equitable approach that supports balanced achievement outcomes across genders.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Mathematics is a fundamental field of study that plays a crucial role in understanding the world and making important discoveries. Its applications are vast, and it provides a powerful tool for solving problems, analyzing data, and making predictions in a wide range of fields. Mathematics is also an important tool in many other fields of study, such as physics, engineering, computer science, economics, and the natural sciences. It helps us make sense of complex systems and relationships, and provides a framework for developing new theories and discoveries. Mathematics can be broken down into several branches, including arithmetic, algebra, geometry, trigonometry, calculus, and statistics. These branches of mathematics help us understand the world around us by describing and modeling real-world phenomena, such as the movement of objects, the growth of populations, or the behavior of financial markets.

Mathematics is an everyday activity subject. Hence, the way it is being taught is important in aiding students to gain basic mathematical knowledge, skills and attitude needed for solving different problems in life. Mathematics is a core subject in Nigerian education system and at secondary school level in particular. According to Joseph (2020), mathematics is a language expressed through symbols, logical relationships, shapes, and numerical representations used to communicate mathematical ideas effectively. Mathematics permeates

everyday life and finds application in areas such as technology, architecture, art, finance, engineering, and sports. Since ancient times, the development of mathematics has played a significant role in the advancement of human civilization and societal growth.

The development of mathematics has always been influenced by the needs and demands of society, with increasingly complex societies requiring more sophisticated mathematical knowledge and skills. Consequently, nations striving for sustainable development and socioeconomic transformation must prioritize quality education that promotes logical reasoning and problem-solving abilities. According to the United Nations Educational, Scientific and Cultural Organization (2021), mathematics and science education are essential for innovation, technological advancement, and the achievement of sustainable development goals. Similarly, United Nations Educational, Scientific and Cultural Organization (2024) emphasized that competencies in mathematics are fundamental for developing scientific literacy and preparing citizens for participation in modern knowledge-based economies. Therefore, national and human development depend considerably on progress in science and technology, for which mathematics serves as a foundational discipline.

According to Olumuyiwa and Akinsola (2021), mathematics is indispensable to the development of science and technology because scientific and technological innovations depend largely on mathematical knowledge and reasoning. Consequently, the position of mathematics in the secondary school

curriculum in Nigeria remains crucial for national development. Owing to its importance, mathematics is offered as a core subject at different levels of education to equip learners with problem-solving abilities, critical thinking skills, and competencies needed for future personal and professional endeavours.

The mode of instruction adopted in mathematics education is influenced by several factors, including learners' characteristics, instructional objectives, and the availability of teaching resources. Recent studies have shown that mathematics instruction in many secondary schools still tends to be predominantly teacher-centred, with greater reliance on conventional lecture methods and textbook-based learning rather than approaches that actively engage students in critical thinking, problem-solving, and the application of mathematical concepts to real-life situations. For instance, Awofala and Lawani (2020) observed that traditional expository teaching remains prevalent in mathematics classrooms despite the increasing advocacy for learner-centred instructional practices. Consequently, the effectiveness of any instructional approach depends largely on the extent to which it incorporates practical and interactive learning experiences that promote meaningful understanding among students. Mathematics like other science subjects, therefore, demands the teacher using appropriate teaching methods that will give students opportunity to be actively involved.

Teaching methods are instructional strategies employed by teachers to facilitate effective learning and achieve predetermined educational objectives.

These methods encompass the organization of instruction, presentation of subject matter, and the use of appropriate teaching resources and techniques. According to Akinsola and Olowojaiye (2021), the choice of instructional method plays a significant role in determining students' engagement and academic achievement. Similarly, Adedoyin and Soykan (2020) emphasized that the effectiveness of the teaching-learning process largely depends on the appropriateness of the instructional approaches adopted by teachers, as suitable methods promote critical thinking, active participation, and independent learning, whereas inappropriate methods may hinder students' interest, creativity, and overall academic performance.

Recent studies have identified several characteristics of effective teaching strategies. First, instructional strategies should stimulate learners' motivation and willingness to learn by creating meaningful and engaging learning experiences. Second, they should facilitate the acquisition, retention, and application of knowledge through well-organized instructional processes. Third, effective teaching strategies should build on learners' prior knowledge and experiences to enhance understanding of new concepts. Finally, instructional approaches should provide opportunities for active participation and collaboration among learners. According to Hwang, Wang, and Lai (2021), learner-centred instructional strategies that encourage engagement, interaction, and knowledge construction significantly enhance students' learning outcomes. Similarly, Adedoyin and Soykan (2020) emphasized that effective instructional approaches should

promote active learning and meaningful participation. Therefore, teaching methods can be viewed as systematic means of communication between teachers and learners aimed at facilitating understanding, promoting behavioural change, and enabling learners to adapt successfully to their environment.

Despite the place of mathematics in the development of our society, many research reports such as Iyoke (2021); Zalmon and Wonu (2017) show that the achievement of students in mathematics at all levels of our educational system is poor. Students' achievement in Mathematics has shown fluctuating trends over the years rather than a stable pattern. Although the percentage of candidates obtaining credit passes and above increased from 65.24% in 2021 to 81.70% in 2022, it slightly declined to 79.81% in 2023 and further dropped to 72.12% in 2024 (see Appendix I). Despite periods of improvement, a considerable proportion of candidates still score below 40%, indicating inconsistencies in students' performance and highlighting the need for sustained efforts to improve Mathematics achievement (WAEC Chief Examiners' Reports, 2021-2024). Iyoke (2021) also buttressed that the achievement of students in senior secondary school Mathematics has not been encouraging from 2011 to 2023. Similarly, Zalmon and Wonu (2017) noted that an analysis of students' achievement in General Mathematics in the May/June West African Senior School Certificate Examination (WASSCE) in Nigeria from 2017 to 2024 revealed poor performance in the subject. This persistent trend in students' low achievement

may not be unconnected with the inadequacy and ineffective utilization of instructional resources required for effective Mathematics teaching and learning.

According to Suleman *et al* (2017), adequate instructional materials means a sufficient set of materials and intellectual contents designed to serve as the major tool for assisting in the instruction of a subject or course. These items may be provided in a variety of forms, bound, unbound, kit, or package form and may consist of hard backed or soft backed, electronic content, consumables, learning laboratories, manipulative, electronic media, and computer software. Instructional materials facilitate and optimize the attainment of specific instructional objective. To arrest students' attention, interest, achievement, curiosity and promote their performance in Mathematics, the use of activity stimulating and student-centered approach like virtual technology/Computer Assisted Instruction (CAI) method instead of depending on the conventional approach needs to be embraced.

Virtualization is technology that lets one creates useful Information Technology (IT) services using resources that are traditionally bound to hardware. It allows one to use a physical machine's full capacity by distributing its capabilities among many users or environments. A number of different virtualization technologies are available in the market today, including the following: Full software virtualization. Hardware-assisted software virtualization or Hardware Virtual Machine (HVM) Paravirtualization or paravirtualized machine (PV) (www.google.com). Virtual Technology (VT) method of teaching

is an instructional approach that employs computer-assisted instruction and information and communication technology (ICT) tools to enhance teaching and learning. Owing to the rapid development of digital technologies, the integration of computers and other virtual resources into mathematics instruction has become increasingly essential. Mulenga and Marbán (2020) noted that emerging digital technologies have created opportunities for transforming mathematics teaching and learning, thereby making technology integration an indispensable component of contemporary mathematics education.

In recent years, education researchers have increasingly advocated for student-centred instructional approaches that shift the focus from teacher domination to active learner participation. Studies have also highlighted the importance of integrating information and communication technology (ICT) tools in mathematics instruction to enhance students' understanding and engagement. According to Bond et al. (2019), student-centred learning environments supported by digital technologies encourage collaboration, autonomy, and self-paced learning among students. Similarly, Crompton and Burke (2021) noted that ICT-based instructional tools in mathematics can present concepts through interactive simulations, animations, and multimedia resources that make learning more engaging and meaningful. These technologies also provide immediate feedback, enabling learners to identify errors and correct misconceptions in real time, while supporting guided learning through prompts and hints. Furthermore, digital learning platforms often offer access to additional

online resources, allowing students to explore related mathematical concepts and strengthen their understanding beyond the classroom.

Recent studies have shown that the integration of virtual and digital learning technologies in mathematics instruction can significantly improve students' academic achievement, motivation, and engagement. For instance, Zhang and Aslan (2021) reported that technology-enhanced learning environments in mathematics not only improve students' conceptual understanding but also increase their interest in learning and encourage collaborative interaction among peers. Similarly, Crompton and Burke (2021) found that digital instructional tools support sustained understanding of mathematical concepts by providing interactive experiences, immediate feedback, and opportunities for active participation, which collectively enhance both cognitive and social learning outcomes.

VT approach refers to the use of computer to give course content instruction in the form of drill and practice, tutorials and simulations (Sedega, et al, 2017). In the words of Suleman et al. (2017), VT is an instructional approach where a computer is used to communicate the instructional materials and evaluate the learning outcomes. Gana (2013) said that VT refers to virtually any sort of computer application in instructional settings comprising of drill and practice, simulations, instructional exercises, supplementary exercises, instructional management, database development, programming, composing

using word processors, and other different applications. That is why Sedega, et al (2017) opined that VT allows the students to direct their own progress.

VT is based on the principles of programmed instruction. Suleman, et al, (2017) stated that the major aim of the programmed instruction is to provide individualized instruction to meet special needs of individual learners. In support of this Sedega, et al, (2017) said that the students might be given various degrees of control over their own learning, instruction could be tailored according to individual student's needs and Feedback on student performance could be stored for further reference under VT instructional approach. Pedagogic experience has shown that the didactic functions of the computer are by no means limited to simple presentation of information, enabling students to acquire and understand a body of knowledge (Sedega, et al, 2017). The advantages of VT method according to Orjika in Suleman, et al, (2017) include, ensuring the application of proven teaching methods to students; offering equal educational opportunities for students by using the same programme; changing the role of the teacher from teaching capacity to that of a guide; also when properly handled, removing fright and embarrassment on students and bringing about meaningful learning and academic achievement (Orjika as cited in Suleman, et al, 2017). VT instruction may also motivate both male and females (both gender) for better achievement in mathematics.

Recent empirical studies have examined the effects of computer-assisted and virtual technology-based instruction on students' achievement in science and

mathematics-related subjects, with particular attention to gender differences. Findings generally indicate that ICT-supported instructional approaches improve students' academic performance regardless of gender. For example, Adeyemo and Babajide (2020) reported that computer-assisted instruction significantly enhances students' achievement in science subjects, while gender has no statistically significant influence on learning outcomes. Similarly, Okoye and Okechukwu (2022) found that technology-enhanced instructional methods improve students' understanding of chemical concepts, with no significant difference in achievement between male and female students exposed to ICT-based learning environments. These findings suggest that virtual and computer-assisted instructional approaches are effective and equitable across gender groups in promoting academic achievement. Mchiri, (2018) observed that males achieved higher than females on exposure to VT approach when the author carried out a study on the effect of computer assisted teaching strategy on students' achievement by gender in agricultural education. Agwagah, Arua and Abugu (2019) found that there is no influence of gender on students' achievement in mathematics when exposed to VT instructional approach.

Julius et al. (2018) on their experiment on the effect of computer aided instruction on students' academic and gender achievement in chemistry among selected secondary school students in Kenya identified that females achieved better than their male counterparts. These contradictory results underscore the complexity of gender-related dynamics in technology-enhanced learning

environments and emphasize the need for further research. Additional studies are necessary to explore how different forms of technology-based instruction such as virtual technology may interact with gender across various subjects, contexts, and learner characteristics to ensure equitable and effective educational practices.

Gender remains a significant factor in mathematics education, influencing students' interest and performance, with recent research indicating that instructional context and technology use can shape these outcomes rather than inherent ability (Wang et al., 2023). Studies in digital mathematics learning show that the use of interactive technologies such as virtual and mixed reality environments can enhance student engagement and motivation, offering potentially equitable learning experiences for both male and female students (Frontiers in Education, 2025). Moreover, investigations into gender and technology-based teaching methods reveal that when appropriately designed and implemented, virtual learning tools may reduce traditional disparities in motivation and achievement by providing engaging, visually supported instruction that appeals to diverse learners (Wang et al., 2023; Novita et al., 2025). Given that gender differences in mathematics achievement and interest are often influenced by socio-cultural expectations and classroom interactions, it becomes important to explore instructional approaches that can minimize such disparities. This is particularly relevant in the context of persistent fluctuations in students' achievement in Mathematics, which suggest that traditional teaching

approaches may not be sufficiently effective in addressing learners' diverse needs. Against this backdrop, examining the effects of a virtual technology teaching strategy provides crucial insight into whether such innovations can foster more inclusive learning environments and enhance both male and female students' interest and achievement in senior secondary school Mathematics in the Federal Capital Territory, Abuja, Nigeria (Wang et al., 2023; Novita et al., 2025).

1.2 Statement of the Problem

The general interest and achievement of students in mathematics has been a great concern to Nigeria and the world at large. Despite the importance of mathematics in our daily activities and our educational system with effort made by researchers and mathematics educators to enhance performance in mathematics, it is very worrisome that students' achievement in mathematics is still low. Students' achievement in Mathematics has shown fluctuating trends over the years rather than a stable pattern. Although the percentage of candidates obtaining credit passes and above increased from 65.24% in 2021 to 81.70% in 2022, it slightly declined to 79.81% in 2023 and further dropped to 72.12% in 2024. (see Appendix I). Several factors have been identified for this not-too-good achievement in mathematics such as the usage and availability of teaching and learning facilities, and teachers' methods of teaching mathematics (Owoeye & Yara, 2020). The teaching and learning of mathematics topics has been frustrated by the nature of the subject content and the instructional strategies

adopted by teachers, thereby resulting in students' poor achievement in both internal and external examinations (Awofala & Lawani, 2020).

The persistent fluctuation in achievement and generally low performance suggest that many students are still not attaining the expected level of understanding and interest in Mathematics. This situation is particularly troubling given the continuous efforts by educators to improve teaching and learning outcomes. It therefore becomes necessary to explore more effective instructional approaches that can enhance students' engagement, interest, and achievement. In particular, there is a need to determine whether Virtual Technology teaching strategy can provide a more interactive and effective learning experience that improves students' interest and achievement in Mathematics. This study is therefore designed to investigate the effects of Virtual Technology teaching strategy on senior secondary school students' interest and achievement in Mathematics in the Federal Capital Territory, Abuja, Nigeria.

1.3 Purpose of the Study

The study investigated the effect of virtual technology teaching strategy on senior secondary school students' interest and achievement in mathematics in FCT Abuja. The specific objectives were to:

i. examine the difference between the interest scores of students taught Mathematics with the Virtual Technology teaching strategy and those taught using the conventional method of teaching in senior secondary schools in the FCT Abuja, Nigeria;

ii. investigate the difference between the achievement scores of students taught Mathematics with the Virtual Technology teaching strategy and those taught using the conventional method of teaching in senior secondary schools in the FCT Abuja, Nigeria;

iii. find out the difference between the interest scores of male and female students taught Mathematics using Virtual Technology teaching strategy in senior secondary schools in the FCT Abuja, Nigeria, and

iv. examine the difference between the achievement scores of male and female students taught Mathematics using Virtual Technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria.

1.4 Research Questions

The following research questions guided this study:

1. What is the difference between the mean rank interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?
2. What is the difference between the mean achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?
3. What is the difference between the mean rank interest scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

4. What is the difference between the mean achievement scores of male and female senior secondary school students taught Mathematics using Virtual Technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

1.5 Hypotheses

The following null hypotheses were generated and tested at 0.05 level of confidence:

Ho_1: There is no significant difference between the mean rank interest scores of senior secondary school students taught Mathematics using the Virtual Technology teaching strategy and those taught the using conventional method of teaching.

Ho_2: There is no significant difference between the mean achievement scores of senior secondary school students taught Mathematics using the Virtual Technology teaching strategy and those taught the using conventional method of teaching.

Ho_3: There is no significant difference between the mean rank scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in the FCT Abuja, Nigeria.

Ho_4: There is no significant difference between the mean achievement scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in the FCT Abuja, Nigeria.

1.6 Delimitation of the Study

This study was delimited to senior secondary school students in FCT Abuja. The study focused on the effect of virtual technology teaching strategy on senior secondary student's interest and achievement in mathematics in the FCT, Abuja. Only public Senior Secondary II (SS2) students were involved in this study. The reason for the choice of public schools is because of the easy access to the schools as the schools are being regulated by government unlike the private schools that the policies of school A, B and C are not regulated by one body which makes it difficult for access. The choice of SS II was out of the researcher's past experience with them during his undergraduate programme. During the undergraduate programme, it was a privilege to carry out Teaching Practice (TP) in Bwari Area Council and during the mandatory TP exercise, it was found that most students have problem with change of subject of formula, right-angled triangle, quadratic equation, linear inequality, logarithm and substitution into formula in mathematics and that is the reason for the selection of the class and the topics for this experiment.

1.7 Significance of the Study

The study would on completion be useful to the students, teachers, government, parents, private firms, non-governmental organizations, and policymakers in the form and implementation of policies that affect virtual technology.

This study is expected to be significant in enhancing students' interest by providing immersive and interactive learning experiences through Virtual Technology. Unlike conventional teaching methods that rely heavily on passive content delivery, Virtual Technology transforms Mathematics learning into an active process where students can explore virtual environments, manipulate objects, and participate in simulated scenarios. This makes Mathematics more dynamic, meaningful, and engaging for learners. Consequently, such enriched engagement is expected to sustain students' interest and motivation, thereby improving their understanding and academic achievement in Mathematics.

The study could also be an opportunity for teachers to differentiate instruction to modify information for the appropriate learning capabilities of their students. The use of virtual technology would also allow students to work at their own paces. By doing these it will ease the work of teachers and also help them identify students' abilities more easily. It will help teachers to integrate new technologies and tools into their classroom. With these mathematics teachers will be able to upgrade and improve the learner-centeredness of their classroom.

It could also be beneficial to parents as this would give opportunity to their children to understand concepts of mathematics easily, perceived it as understandable subject and develop interest in it, so that they can likely study mathematics in higher institutions.

Curriculum planners (policy makers) could also benefit from the findings as it will identify areas that needs adjustment and modification into mathematics

and other math-related subjects, as their main objective is to enhance students' conceptual performance. Hence the findings could help them achieve their main goal. The result of this study may also provide curriculum planners necessary information that may be of importance when curriculum review is needed. The curriculum planners may use the result to measure students' conceptual understanding and interest in mathematics.

From the finding, government and non-governmental organizations including private sectors would note areas that need their support to enhance mathematics teaching and learning in the area. Till date mathematics form the bedrock of every nations intellectual prowess and economic development. However, the journey towards achieving excellence in mathematics education face multifaceted challenges ranging from inadequate resources to outdated teaching methodologies. But from the finding of the study it will help guide government and non-governmental organization and private sectors on the next line of action in the area.

1.8 Operational Definition of Terms

The following are the operational definition of terms as they are used in the study:

Virtual Teaching Strategy: Refers to the use of digital technologies such as online platforms, multimedia resources and virtual learning environments to deliver Mathematics instruction to secondary school students.

Achievement in Mathematics: Refers to the level of proficiency or success that secondary school students attain in Mathematics.

Interest in Mathematics: Refers to the degree to which secondary school students are engaged, motivated and enthusiastic about learning Mathematics.

Computer Assisted Instruction: The use of the computer as a tool to facilitate and improve instruction. A CAI program uses a combination of text, graphics, sound, and video to enhance teaching and learning process.

Virtual Technology: The use of technology online and offline in education to make learning more engaging, accessible, and interactive for both students and teachers.

Conventional Method: The teaching approach currently adopted by mathematics teachers as a medium of instruction in public Senior Secondary Schools (SSS) Abuja.

Information and Communication Technology: is a modern way of generating, processing and distributing data using computer hardware and software, telecommunications, and digital electronics.

Paravirtualization: Paravirtualization is a computer hardware virtualization technique that allows to have an interface similar to that of the underlying hardware.

Virtual Reality-based Instruction: this means the use of virtual reality technology such as games, simulation or virtual world in teaching and learning process.

1.9 Abbreviations

CAI - Computer Assisted Instruction

FCT - Federal Capital Territory

HVM - Hardware Virtual Machine

ICT - Information and Communication Technology

PV - Paravirtualization

SSCE - Senior School Certificate Examination

SSS - Senior Secondary School

TM - Traditional Method

VT - Virtual Technology

WAEC - West Africa Examination Council

WASSCE - West Africa Senior Secondary Certificate Examination

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 Introduction

In this chapter, literature related to the study was reviewed. The review was presented based on the subheadings: conceptual framework, conceptual analysis, theoretical framework, review of previous studies and summary.

2.2 Conceptual Framework

The conceptual framework of the study is as presented in Figure 1.

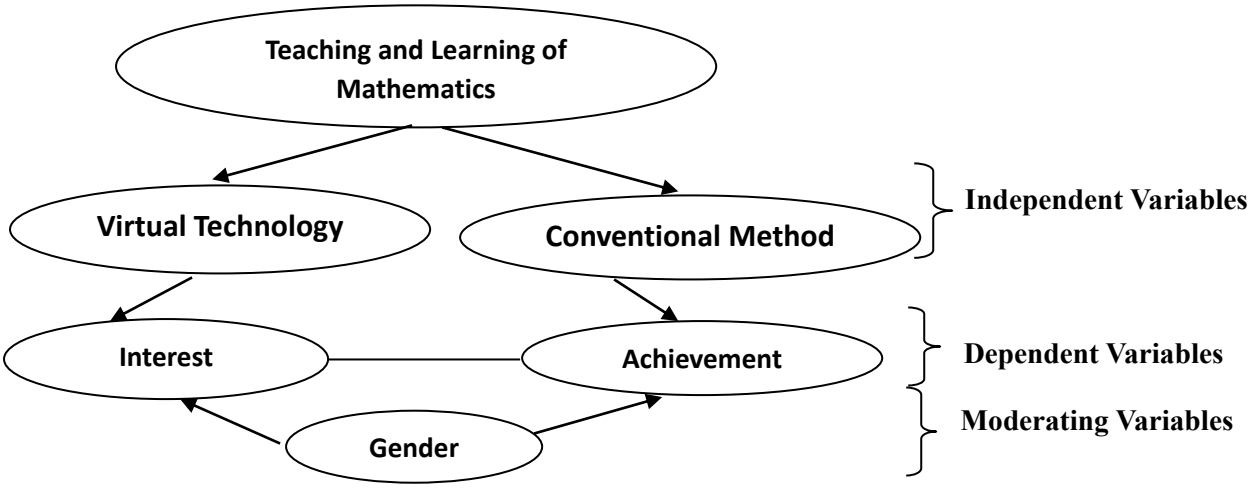

Figure 1: Conceptual Framework

Figure 1 is a conceptual framework showing the relationship between the independent and dependent variables. The virtual technology teaching strategy serves as the independent variable, posited to enhance both students' interest and achievement in mathematics, which are the dependent variables. Such teaching strategy fosters engagement and collaboration among learners, which has been shown to improve academic outcomes in mathematics education.

Gender as a moderator variable influences the effectiveness of virtual technology teaching strategy, as well as the levels of student interest and achievement in Mathematics.

2.3 Conceptual Analysis

This is a research methodology that clarifies complex concepts by breaking them down into their constituent parts. In the context of virtual technology teaching strategy, it can help define the concept, identify its key components and examine its theoretical underpinnings.

2.3.1 Concept of Mathematics

Mathematics is a fundamental subject taught at the senior secondary school level. It is a subject that is essential for students to understand as it forms the basis for many scientific, technological, and engineering applications. Mathematics is the study of numbers, quantities, shapes, patterns, and their relationships and operations. It encompasses diverse areas such as algebra, geometry, trigonometry, calculus, statistics, and probability (Ben, 2023).

Mathematics is an essential subject taught in senior secondary schools in Nigeria. It is a broad field that deals with the study of numbers, quantities, and shapes. Mathematics in senior secondary school builds upon the foundation of basic arithmetic and elementary algebra taught in primary and junior secondary schools. The concepts learned in senior secondary school mathematics are crucial for students who want to pursue careers in science, technology,

engineering, arts and mathematics (STEAM) (National Council of Teachers of Mathematics, NCTM, 2018).

The study of mathematics at the senior secondary school level is essential because it fosters students' critical thinking, logical reasoning, analytical abilities, and problem-solving skills. It also serves as a fundamental basis for advanced studies and careers in disciplines such as science, engineering, economics, technology, and finance (OECD, 2019).

Some of the key concepts taught in senior secondary school mathematics include:

1. Algebra: Algebra involves the use of symbols and letters to represent numbers and quantities. It includes topics such as equations, inequalities, polynomials, and functions.
2. Geometry: Geometry is the study of shapes and their properties. It includes topics such as angles, lines, circles, triangles, and polygons.
3. Trigonometry: Trigonometry is the study of the relationships between the sides and angles of triangles. It includes topics such as trigonometric functions, identities, and equations.
4. Calculus: Calculus is the study of rates of change and the accumulation of small changes to obtain a larger result. It includes topics such as differentiation, integration, and limits.
5. Statistics and Probability: Statistics is the study of data and how to interpret it, while probability is the study of the likelihood of events

occurring. Topics covered include data analysis, measures of central tendency, probability distributions, and hypothesis testing.

The 21st century has seen remarkable advances in mathematics in various fields, such as Topology and Geometry, Number Theory, Mathematical Physics, Data Science and Optimization. These advancements have led to a deeper understanding of fundamental mathematical concepts, as well as the development of new techniques and tools for solving complex mathematical problems (Percy, 2017). Overall, advances in mathematics in the 21st century have significantly influenced scientific discovery, technological innovation, and societal development, and these contributions are expected to continue shaping future progress across diverse fields (Bakhoum & Brown, 2019).

2.3.1.1 Teaching and Learning of Mathematics

Young children learn from watching and listening and engaging with the world around them. New skills and understandings can emerge through demonstration, modelling and problem solving. In early years settings educators enrich learning activities by using mathematical language that helps children to explore, describe and understand the world around them and builds strong foundations for future learning in mathematics. Evidence shows that the use of high-quality curriculum resources, together with pedagogy that responds to and adapts to the needs of students leads to increased engagement and improved student outcomes (Australian Education Research Organisation (AERO), 2022).

There are several effective teaching methods for Mathematics at the senior secondary level. These are Inquiry-Based Learning, Collaborative Learning, Direct Instruction, Problem-Based Learning and Technology-Based Learning. The choice of teaching method will depend on the learning objectives, the needs of the students, and the teacher's preferences and strengths. A combination of these methods may be used to ensure that students are engaged and motivated to learn Mathematics.

In a mathematics learning space, it is important to create a rich learning environment that encourages a positive mindset and opens up the potential for growth in mathematics teaching and learning. Using a range of teaching strategies that connect the content, skills and concepts will enhance understanding and engagement and build students' confidence as mathematics learners and thinkers.

In the mathematics learning space, students are exposed to opportunities that help them to:

1. develop and engage their mathematical thinking
2. solve problems and demonstrate their understanding
3. apply strategies and conceptual understanding in familiar and unfamiliar situations
4. recognize the relevance of their experiences in their environment through a mathematical lens

5. Use and connect what they are learning to contexts outside the mathematics classroom.

Teachers help students to engage with, explore and make connections between their mathematical knowledge, skills and understandings with other learning areas and the world around them.

2.3.2 Students' Interest in Mathematics

Many studies have put effort in intervening an approach to promote and develop students' interest in learning mathematics. The Interest-Driven Creator (IDC) theory suggests that students can be nurtured as creators after they have engaged in interest-driven learning activities regularly with technology support (Chan et al., 2018). There are three anchored concepts in the IDC theory, namely, interest, creation, and habit, whereas each of them will go through to continuum learning activity that subsequently forms a loop (Chan et al., 2018).

Firstly, the interest loop comprises three coherent components which are triggering interest, immersing interest, and extending interest (Wong et al., 2015). In the IDC theory, stimulating curiosity is one of the processes in triggering situational interest; however, presenting attractive learning subject matters is inadequate for this purpose. To provoke situational interest, teachers or instructional designers should scaffold knowledge deficit, which subsequently can help students be immersed or fully engaged in the learning process by providing optimum levels of challenging learning tasks. As for the final component in the interest loop, it explains that utility implications of the learning

content are crucial for sustaining students' interest (Wong et al., 2015). In relation to mathematics learning, students' interest can be promoted by firstly presenting a mathematical problem that is able to provoke and confront students' prior knowledge, and scaffold students to tackle challenges that help students gain successful experiences and finally present the practical value of the learning content.

Next in the creation loop, there are three components which are imitating, combining, and staging (Chan et al., 2018). According to Chan, et al (2015), the early stage of learning process includes imitation from a model, as an attempt to understand the model's ideas, methods, or ways of doing things. Then, students will choose what to retain or remove, and come up with their own interpretation or ideas as a result of 'combination'. To complete the creation process, students should be provided with a platform to present their product (Chan et al., 2015). In the context of learning mathematics, the creation loop can be operationalized as simply as a mathematics problem-solving situation in a classroom. Mathematics teachers usually demonstrate a step-by-step method to approach a mathematics question, and in return, students are asked to imitate the process for a similar question. When students are able to solve the question on their own, it can be known as a completed 'combination' process as they have acquired the skills and knowledge to answer a mathematics question. Staging can be as straightforward as showing their working solution on the board in the classroom to their peers.

In addition, the habit loop consists of three components: cueing environment, routine, and satisfaction (Chen et al., 2015). In the view of the IDC theory, it is important and possible to develop a positive learning habit to nurture a lifelong interest-driven creator (Chen et al., 2015). Although the habit formation process takes time and is highly related to students' affective characteristics and cognitive behaviours, teachers should begin with easy and simple habits; therefore, it comes down to the question of what is the learning habit teachers would like students to form (Chen et al., 2015). Regarding learning mathematics, there are a few fundamental and important learning habits like memorization of the multiplication table, the accurate and systematic way of writing mathematics equation, or an analytic approach in solving mathematics questions. In the process of developing students' interest towards mathematics, it is inevitable that students are required to be innately involved in solving a mathematics problem regularly, and that is when habits come into play, to help them be comfortable, familiar, and most importantly, answer a mathematics question correctly as guided by the teacher.

Finally, in the long term, as conceptualized in the IDC theory, students' satisfaction towards learning can be increased with increasing successful experiences (Chan et al., 2018; Chen et al., 2015). As widely believed, interest has a vital role in mathematics learning (Yu & Singh, 2016). In this study, interest is operationally defined as students' affective state of being engaged in mathematics learning whereby students enjoy the learning process. Several

studies have established that students' interest in learning is a significant determinant of academic success. Research has shown that students' interest and engagement are positively associated with improved academic achievement (OECD, 2019). Similarly, studies have reported a significant relationship between students' interest in mathematics and their performance in the subject (Wang et al., 2023). Furthermore, students with higher levels of interest and intrinsic motivation tend to exhibit lower mathematics anxiety and better achievement outcomes (Novita et al., 2025). In addition, mathematics self-efficacy has been found to positively influence students' interest and performance in mathematics (Juandi et al., 2021). To stimulate students' curiosity and enhance their achievement in mathematics, the adoption of activity-based and learner-centred approaches such as virtual technology has become imperative.

2.3.3 Students' Achievement in Mathematics

Mathematics achievement is an essential part of the academic achievement in the modern era. It is the key to success in many professions. Mathematical achievement also is the competency shown by the student in mathematics. It is the result of acquired knowledge or information, understanding, skills and techniques developed in the subject of mathematics in a particular stage. Its measure is the score on the achievement test in mathematics (Bhairab, 2017). The study intends to find possible ways students can achieved greater in mathematics through virtual technology.

In the 21st century, mathematics has become the backbone for the prosperity in each and every field of life. Mathematics is well known as a father of all sciences. It is impossible to think about any scientific study without mathematics. Mathematics is the knowledge of 3R's that is, reading, writing and arithmetic. Each student in his day-to-day life has to achieve certain vital goals and objectives. Mathematics works as a base-camp to achieve these objectives. Every stage of education has its own importance. Secondary education lays the basic foundation for all types of higher education. Successful achievement in mathematics at Secondary stage, especially senior secondary grade is prerequisite for better academic achievement in higher stage. Mathematics achievement is an essential part of the academic achievement in the modern era. It is the key to success in many professions.

Guskey (2020) defined achievement test is a measurement instrument designed to determine the extent to which learners have acquired knowledge, skills, and competencies in a particular subject after a period of instruction by assessing their current level of performance. Mathematical achievement is the competency shown by the student in mathematics. It is the result of acquired knowledge or information, understanding, skills and techniques developed in the subject of mathematics in a particular stage. Its measure is the score on the achievement test in mathematics (Bhairab, 2017).

The concept of achievement in Mathematics refers to a student's ability to solve mathematical problems and demonstrate their understanding of

mathematical concepts. Mathematics achievement can be assessed through a variety of measures, including standardized tests, classroom assignments, and teacher observations.

One important factor that influences students' achievement in mathematics is their prior knowledge and skills. Students who enter the classroom with a strong understanding of foundational mathematical concepts and procedures are more likely to achieve better learning outcomes than those with limited background knowledge. Since mathematical concepts are hierarchical and cumulative in nature, mastery of basic concepts enables learners to comprehend and solve more advanced mathematical problems effectively (Susac et al., 2022).

Finally, it is worth noting that achievement in mathematics is not a static or fixed concept. Rather, it is a dynamic and evolving process that can be influenced by a range of factors over time. Students who struggle with math early on may be able to improve their achievement with the right supports and interventions, while high-achieving students may need new challenges and opportunities to continue to grow and develop their mathematical skills. In conclusion, achievement in Mathematics is a complex concept that is influenced by a variety of factors, including individual aptitude, motivation, study habits, classroom environment, curriculum, and parental involvement.

2.3.4 Gender Issues in Teaching and Learning Mathematics

The issue of gender in teaching and learning mathematics has been a topic of concern for educators and researchers for many years. Research has shown

that females remain underrepresented in many mathematics-related and STEM fields, and several factors contribute to this disparity. One of these factors is the persistent stereotype that mathematics is a male-oriented domain, which can negatively affect girls' confidence, interest, and participation in mathematics. Studies have revealed that gender stereotypes and perceptions about mathematics influence students' attitudes toward the subject, with girls often reporting lower self-confidence and perceiving mathematics as more challenging despite having comparable abilities to boys (Master et al., 2021; OECD, 2019).

In addition, research has shown that gender bias and stereotype-related experiences may occur in mathematics classrooms. Female students may receive less encouragement and recognition for their mathematical abilities and may become more sensitive to criticism when mistakes are made. These experiences can negatively affect their interest, self-confidence, and achievement in mathematics (Bian et al., 2018).

Despite increasing awareness of gender equity in education, misconceptions that mathematics is a difficult subject and a male-dominated field persist among students, parents, and society. These stereotypes have continued to influence female students' participation and enrolment in mathematics-related disciplines. Research has shown that girls often face social and cultural barriers that portray mathematics as more suitable for males, thereby affecting their confidence, interest, and willingness to pursue mathematics studies. Consequently, female representation in mathematics classrooms and

related careers remains lower than that of males in many contexts (Master et al., 2021; UNESCO, 2024).

To address these issues, educators and researchers have developed a range of strategies to promote gender equity in mathematics education. These strategies include:

1. Encouraging a growth mindset: Teachers can foster a growth mindset in students by emphasizing that mathematical ability is not fixed but can be developed through effort, practice, and effective learning strategies. Research has shown that growth mindset interventions can improve students' motivation and achievement in mathematics (Yeager et al., 2019).
2. Providing role models: Teachers can highlight successful female mathematicians and scientists to challenge stereotypes and encourage girls to view themselves as capable of excelling in mathematics. Exposure to female role models has been shown to increase girls' motivation and interest in STEM-related subjects (Herrmann et al., 2018).
3. Promoting collaborative learning opportunities: Collaborative and cooperative learning strategies have been found to enhance participation and engagement in mathematics, particularly among female students, by creating supportive peer-learning environments (OECD, 2019).
4. Addressing gender bias: Teachers should consciously ensure fairness in feedback, classroom interaction, and assessment practices, as unconscious

bias can influence students' confidence and performance in mathematics (UNESCO, 2024).

5. Incorporating real-world applications: Integrating real-life contexts in mathematics instruction helps students understand the relevance of mathematical concepts, thereby increasing engagement and reducing gender-based differences in interest (Boaler, 2020).

Overall, promoting gender equity in mathematics education requires a multifaceted approach that addresses motivational, instructional, and socio-cultural factors. Implementing inclusive teaching strategies can help create equitable learning environments that support all learners regardless of gender (UNESCO, 2024).

2.3.5 Virtual Technology Teaching Strategy in Mathematics Education

Virtual technology teaching strategy in mathematics education refers to the use of digital tools to create simulated or augmented learning environments that allow students to interact with information and concepts in new and engaging ways. This technology has the potential to transform traditional classroom instruction, enabling educators to create more immersive, interactive, and personalized learning experiences. One of the most significant benefits of virtual technology in mathematics education is its ability to enhance students' interest and academic achievement. By providing interactive, immersive, and student-centred learning environments, virtual technologies help sustain learners' attention and engagement in the learning process. This approach is particularly

beneficial for students who struggle with traditional instructional methods or who have diverse learning needs and preferences (Radianti et al., 2020; Hamilton et al., 2021).

Virtual technology in mathematics education also creates opportunities for collaboration and communication among students and teachers regardless of physical distance. Through virtual classrooms and online learning platforms, students can engage in group activities, share ideas and resources, and receive timely feedback from peers and instructors. In addition, virtual learning environments improve access to educational resources such as digital libraries, interactive content, and multimedia materials, which help reduce disparities caused by limited access to traditional instructional resources (Bond et al., 2020; Zydney et al., 2020).

Virtual technology teaching strategy in mathematics education refers to the use of digital tools and software that simulate mathematical concepts and allow learners to explore and interact with mathematical objects in a virtual environment. Virtual technology teaching strategy has the potential to improve students' understanding of mathematical concepts, as it provides visual and interactive representations that help students visualize abstract concepts and make connections between mathematical ideas.

One example of virtual technology teaching strategy in mathematics education is the use of dynamic geometry software (DGS) such as Geogebra or Cabri, which allows students to construct and manipulate geometric figures on a

computer screen. This software can be used to enhance students' understanding of geometric concepts such as congruence, similarity, and symmetry by allowing them to explore and test conjectures using interactive visualizations. (Hohenwarter et al., 2018).

Another example of virtual technology in mathematics education is the use of mathematical simulations, which enable students to model and explore real-world phenomena through mathematical concepts. For instance, simulations can be used to represent the spread of diseases, financial market fluctuations, or population growth dynamics. Such tools help students to better understand complex mathematical relationships by visualizing and interacting with dynamic systems in a virtual environment (De Jong et al., 2020; Ma & Nickerson, 2019).

In addition to dynamic geometry software and simulations, emerging virtual technologies such as virtual reality (VR) and augmented reality (AR) can further enhance mathematics education. Virtual reality provides immersive three-dimensional environments that allow students to explore and interact with mathematical concepts in an engaging and experiential way, while augmented reality overlays digital mathematical objects onto real-world settings, making abstract concepts more visible and concrete for learners. These technologies have been shown to improve understanding, engagement, and conceptual visualization in mathematics learning (Radianti et al., 2020; Sirakaya & Alsancak Sirakaya, 2022).

Overall, the use of virtual technology teaching strategy in mathematics education has the potential to enhance students' understanding of mathematical concepts by providing interactive visualizations and simulations that help students make connections between mathematical ideas. As technology continues to advance, it is likely that virtual technology teaching strategy will become an increasingly important tool in enhancing students' interest and achievement in mathematics education (Rasmussen & Ellis, 2018).

2.4 Theoretical Framework

Several theories have been developed that fit all VT requirements, but this study is theoretically underpinned by two carefully selected learning theories to form the framework. The two selected learning theories are Constructivism Learning Theory (Dewey, 1933) and Cognitive Information Processing Learning Theory (Atkinson, 1968).

2.4.1 Constructivism Learning Theory

John Dewey (1859–1952) is often considered the philosophical founder of constructivism learning theory. This theory was propounded in 1933. He argued against the notion that schools should focus on repetitive, rote memorization, and proposed that students should engage in real world, practical, and workshops that would enable them demonstrate their knowledge through creativity and collaboration (Dewey, 1933). In constructivist approach, learning is an active process in which the learner uses his sensory input and constructs meaning out of it.

To the constructivists, learning can point to different teaching practices. This indicates that the approach encourages students to use active techniques to create more knowledge reflect on it, talk about what they are doing, and how their understanding is changing. The constructivists did not completely dismiss the role of the teacher in the classroom, but argued that adult teachers only guide the students on how to perform a task. The process of students' engagement with their peers will enable them refine their thinking or their performances in a given task. According to Dewey, the crucial action of constructing meaning is mental, and this occurs in the mind. He stressed further that physical actions and hand-on experience maybe necessary for learning, but this is not sufficient. Teacher may need to provide activities, which engage the mind of students as well as their hands. This brings about the reason why the researcher considers this theory appropriate for the study.

The simple idea of constructivism learning theories, that (1) learners construct new understandings by using what they already know, and (2) that learning is not passive but rather active was evident through the use of VT in mathematics classroom as reported by many students. This implies that teaching is not viewed as the transmission of knowledge from enlightened to unenlightened. The Constructs teacher only serves as a guide to students as more knowledgeable person who provides students with opportunities to test the adequacy of their current understanding, and apply this to the new situations. In the new situations, students are engaged to build their knowledge, and are

encouraged on group interactions where the interplay among the participants helps individual student becomes explicit about his/her own understanding by comparing it to that of their peers. It is based on the idea of constructivism as stated above that this study is to find out whether virtual technology will also serve the same purpose in mathematics.

Constructivism is a learning theory which holds that knowledge is best gained through a process of reflection and active construction in the mind. The theory states that a learner is an information constructor. It emphasizes the fact that knowledge is constructed based on personal experience and hypotheses of the environment and that learners continuously test these hypotheses through social negotiations. A constructivist emphasizes how meanings and understandings grow out of social encounters. He argues that learning is passed down from generation to generation and that it is the result of guided social interaction in which children work with their peers and a mentor to solve problems.

Constructivism Learning Theory is highly relevant to the study because it explains how learners actively construct knowledge through interaction, experience, and reflection rather than passively receiving information. Constructivism posits that students learn best when they are actively engaged in exploring concepts, solving problems, and relating new knowledge to prior understanding. Virtual technology teaching strategies such as simulations, virtual manipulatives, dynamic geometry environments, and interactive visualizations,

provide exactly this kind of learner-centred environment. These tools allow students to manipulate mathematical objects, test ideas, observe outcomes, and draw conclusions, thereby supporting meaningful learning.

The theory is particularly relevant to students' interest and achievement because it emphasizes engagement and active participation. When students interact with virtual environments, mathematics becomes more concrete, visual, and enjoyable, which increases their curiosity and motivation. This heightened engagement is likely to improve their interest in mathematics. Furthermore, constructivism supports collaborative and exploratory learning, which virtual platforms often encourage through group tasks, peer discussion, and guided discovery. These experiences help students develop deeper conceptual understanding, which translates into improved academic achievement. Therefore, Constructivism Learning Theory provides a strong theoretical foundation for this study as it justifies the use of virtual technology as a teaching strategy that enhances active learning, improves conceptual understanding, increases student interest, and ultimately boosts achievement in mathematics.

2.4.2 Cognitive Information Processing (CIP) Learning Theory

The cognitive information processing (CIP) learning theory of Atkinson in 1968 sees teaching and learning as a system of activities deliberately and methodically created to induce students' learning of specific content. The theory is concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. CIP views the human mind as a system

that processes information according to a set of logical rules and limitations similar to those with which a computer is programmed. It emphasizes that comprehension is aided as learners become actively involved in the learning process through group interactions, active student participation, small steps, immediate feedback, and reinforcement of information (Atkinson, 1968).

The key items in CIP are (1) the effect of stimuli on the organism's receptors (2) the storage of information in short-term memory (working memory) (3) the storage of information in long-term memory (4) the process involved in encoding and decoding information, and (5) the retrieval of stored information, and analyzing its ultimate effects on the behaviour of the organism. The virtual technology teaching strategy provides a platform whereby students perform tasks that are tailored to their developmental level and are motivating.

Also, cognitive information processing theory focuses on what happens in the mind and the information that came in from the environment is processed by a sense of temporary sensory memory system and then fed into a limited capacity short term stores. In the present study the use of VT teaching strategy is guided by the theory to modify the teaching and the learning environment to facilitate the students' interest and achievement, make suggestions, and teach skills to stay active in working memories. VT teaching strategy enables students learn best when a concrete object or activity is used in the classroom.

The theory is interested in how people understand material and learning activities. Cognitive theory is an approach to psychology that attempts to explain

human behaviour by understanding thought processes. It emphasizes how people comprehend and represent the outside world internally and how ways of thinking about the world influence behaviour. The assumption is that in humans, thoughts are the primary determinants of emotions and behaviours. They considered that although changes do occur in learning, they are an indirect outcome of learning. The theorist argued further that students construct cognitive processes, higher-order thinking skills and mental representations when they are actively acquiring information. The theorist maintain that attainment comes from the application of critical thinking skills and the understanding of essential concepts. The theorists stress that learning involves the transformation of information in the environment into knowledge that is stored in the mind. Learning occurs when new knowledge is acquired, or when existing knowledge is modified by experience. Virtual technology teaching strategy seems to have the same orientation with the CIP when used in teaching mathematics.

The fundamental concept of cognitive theory involves how people think and gain knowledge. The theory attempts to understand how problem-solving changes throughout childhood and how cultural differences affect the way people view our academic achievement and language development. The VT teaching strategy classroom allows a teacher to maintain a proper balance between critically guiding the students and allowing opportunities for them to explore things on their own to learn through discovery. The teacher acts as facilitator rather than as a dispenser of repository knowledge. Students are given

opportunities to explore the world around them and make meaningful contributions to learning thereby making learning learner centered.

2.5 Review of Previous Studies

There are some previous research studies conducted related to virtual technology teaching strategy on students' interest and achievement in Mathematics.

Navarro-Ibarra et al (2017) proposed taking advantage of technology for teaching-learning mathematics. The objective is to determine whether a Virtual Leaning Environment (VLE) for mathematics can diminish the indexes of failing and improve academic performance. The study has a pretest-posttest quasi-experimental design with a nonequivalent control group. The participants are engineering students at the Instituto Tecnológico de Sonora (Technological Institute of Sonora), Mexico. 68 students participated in the experimental group and 60 in the control group. The experimental group studied academic subjects using VLE while the control group studied in a classroom with a professor who explained the concepts. The results show significant difference in the index of failing and academic performance. The implementation of VLE for mathematics would be beneficial to the extent that it is designed using pedagogical practices within a context supported by technology. The study is related to this study as both are working towards Virtual Leaning Environment but the objective of the other study is to determine whether a Virtual Leaning Environment (VLE) for mathematics can diminish the indexes of failing and improve academic

performance in Mexico, somewhat contrary to the current study whose overall objective is to investigate the effect of virtual technology teaching strategy on senior secondary students' interest and achievement in mathematics in Bwari Area Council of the FCT.

Allahnana et al. (2018) assessed gender and interest in mathematics achievement in Keffi Local Government Area of Nasarawa State, Nigeria. Three objectives were raised in relation to 3 hypotheses. The study adopted ex-post fact of research design. The target population for this study consisted of 3548 SS 3 students' in 2017/2018 academic session from 24 Senior Secondary Schools. The population was made up of 2,705 male and 843 female students. The sample of this study consist 361 SS 3 students which involved 182 male and 179 female students'. The researchers developed a single Performa as instrument for data collection. Logical validity index of 0.89 and 0.82 were obtained with the rational consensus of 0.85. Descriptive statistics of mean and standard deviation were used to answers research questions while inferential statistics of biserial correlation was used to test the formulated hypotheses at the 0.05 level of significance. The study found that male students excel in mathematics achievement more than their female counterparts. And male students have interest in mathematics than female students that is to say; there is significance relationship between male and female and interest in mathematics. The authors assess gender and interest in mathematics achievement, something similar to the current study, but unlike the current research, they have deemphasised the virtual

technology aspect of teaching/learning, leaving a gap to be filled by the existing study.

Bowen (2018)'s purpose of this quasi-experimental study was to examine the influence of virtual reality field trips on middle-school students' social studies academic achievement and motivation. The introduction of low-cost hand-held devices has provided K-12 educators with the opportunity to teach using virtual reality (VR). However, the efficacy of VR in K-12 classrooms for teaching and learning has not been established. The district chosen for the study is in a rural, economically depressed county, where generational poverty persists. However, the district has a history of being an early adopter of technology. Participants included 76 seventh grade students at two middle schools, who participated in social studies instruction using either the traditional lecture method or a virtual reality system. The virtual reality system used in this study was the Google Expeditions Virtual Reality System, which uses smartphone technology and iBlue Google VR 3-D Glasses. Before and after the instruction was provided, participants were assessed using the Instructional Materials Motivation Survey (IMMS) and teacher designed social studies test. The results of the two one-way ANCOVAs, demonstrated that students using virtual reality scored significantly higher than students participating in traditional instruction on both their academic achievement and motivation. These findings provide support for the use of virtual reality in middle-school social studies classrooms. The reviewed study is related to the present one as they both investigate the use

of virtual technology strategies on students' achievement. But this author's research is primarily on field trips, and specifically on middle-school students.

Fabian et al. (2018) investigated the effects of using mobile technologies to students' attitudes and achievement. A quasi-experimental mixed method design was adopted. Participants were 52 Primary 6 and 7 students. The experimental group participated in a weekly mobile supported, collaborative learning activities spanning over three months. A no treatment control group was adopted. The experimental group have positive perception of the activities evidenced by student interviews and end activity evaluations. Students' attitude to mathematics, as assessed by a mathematics attitude inventory, found no significant change for both groups except for the significant decline in enjoyment for the control group. The gain scores between groups showed a significant difference which indicated that the experimental group had higher gains than the control group. These results indicate that the use of mobile technologies elicit positive responses from students both in terms of how they perceive the mobile activities and how it improved their performance but its' effect on students' attitudes towards mathematics will need to be further investigated. The reviewed study is also related to the present one as it investigated the effects of using mobile technologies to students' achievement. The current study is however anticipated to produce different results as it is on students' achievement in mathematics. Participants in the studies also vary; while

these researchers chose Primary 6 and 7 students, the current research chooses mathematics students of the secondary school.

Abidin et al. (2018) looked at Gender-related differences in the use of technology in mathematics classrooms: Student participation, learning strategies and attitudes. The purpose of this paper was to investigate the affective domain in learning mathematics with technology across genders and across two student groups, where in one group the students shared learning devices, while the other group of students used individual devices. The study adopted both quantitative and qualitative methods and is based on data collected from five secondary schools in Indonesia. The findings revealed attitudinal differences are associated with technology usage in mathematics classrooms. Quantitative measurements across four attitudinal subscales—mathematics motivation, attitudes to the use of technology in mathematics, technological confidence and mathematics confidence indicate that affordances in technologies influence boys' and girls' attitudes; while qualitative data share further insights on gender perspectives related to attitudinal differences. The reviewed study is of the present kind with its focus on the use of technology in mathematics classrooms, considering student participation, learning strategies and attitudes. The authors are of the view that the use of technology in education is still seen as a symbol of modernity, in a similar fashion that great performance in mathematics is achievable when the students are exposed to virtual technology teaching strategy.

The study was however carried out in Indonesia, as against Bwari Area Council, the area of the current study.

Moreover, Lund, and Wang (2019) examined "Effect of Virtual Reality on Learning Motivation and Academic Performance: What Value May VR Have for Library Instruction?" the study aims to examine what impact VR has on student learning motivation and performance. It indicates that VR provides a small improvement in academic performance and a large improvement in student engagement. The application of VR in libraries focuses on providing the VR tools to learn subjects in STEM and history fields. For one-off instructional settings, the boost of learning motivation may increase interest in further investigation and retention. For semester-long courses, increased learning motivation may decrease student attrition or “failure” in the information literacy course. The researcher exposed participants to virtual reality, the result of the study revealed that virtual reality increased the learning motivation of students. The reviewed study is related to the present one as they both expose experimental groups to virtual technology-based instruction. But while these authors hinge on Learning Motivation and Academic Performance, the current research hinges on how virtual technology teaching impacts positively on the academic achievement of senior secondary school mathematics students.

Ityavzua (2019) worked on the effect of virtual mathematics laboratory on senior secondary school student’s interest in circle geometry in north-central geopolitical zone, Nigeria. This study was empirically

designed to determine the effect of virtual mathematics laboratory on senior secondary school students' interest in circle geometry in North-Central Geopolitical Zone, Nigeria. Three research questions and nine hypotheses guided the study. A quasi-experimental research design was used. Specifically, non-equivalent pre-test, post-test control groups design, involving two intact classes. The population for this study consisted of a total of 5657 students in SS2 from Co-educational Federal Government Colleges in the North-Central. The sample for this study consisted of 96 students (55 males and 41 females). A purposively sampling technique was first employed to select ten (10) Co-educational Federal Government Colleges in the North-Central. A simple random sampling technique was then employed to draw two Co-educational Colleges and one intact class from each college and assigned to Experimental (VML) and Control (TML) groups. The instrument for data collection was Geometry Interest Inventory (GII) developed and validated by the researchers. The internal consistency of GII was determined and established to be 0.92 using Cronbach's Alpha (α). The research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 significant level. The results obtained from this study indicated that type of mathematics laboratory had significant effect on students' interest in circle geometry. Students taught circle geometry using VML had significant higher interest in circle geometry than those taught with TML. However, gender did not significantly influence students' interest in circle geometry. It was also revealed

from this study that, type of mathematics laboratory and gender had no significant interaction effect on students' interest in circle geometry. The reviewed study is also observed to be related to the present one as they are both concerned with virtual technology method of instruction. However, while the former is restricted to virtual mathematics laboratory on senior secondary school students, and the specific aspect of geometry, the present study investigates virtual technology teaching strategy generally on senior secondary students' interest and achievement.

Nwadiokwu (2019) looked at Implementation of educational technology in the 21st century secondary schools in Delta State: Issues, challenges and prospects. The paper examines the future of Educational Communication in Technologies in the 21st century, its challenges and prospects for teachers and students. The population consisted of all teachers and students in secondary schools in Delta State. Simple random sampling techniques were used to select one hundred (100) respondents from ten secondary schools across the three senatorial districts of Delta State. The descriptive survey design was employed for the study. To guide the study, three hypotheses were formulated. The questionnaire structured "Future Educational Technology in the 21st Century (FETIC) was used as the instrument for data collection. The data collected were analyzed using the chi-square method to test for the acceptance or rejection of the hypotheses. The finding revealed that while educational technologies have potential benefits, they are also causing serious threats to system security and

personal privacy. The reviewed study is related to the present study only for the fact that they both examine the technological aspect of education, teaching inclusive. Every other issue found in the current work suggests a gap in the other research.

Okoye and Okwo (2019) examined teachers' resistance to the use of educational communications technology in state-owned tertiary institutions in Enugu State, Nigeria. The study was undertaken to examine: (i) factors that cause teachers resistance to the use of educational communications technology (ii) identify administrative strategies that can be used to encourage teachers to use educational communications technology. The study is anchored on Technology Acceptance Model (TAM). A descriptive survey research design was adopted. A sample of 45 lecturers of three tertiary institutions, obtained through simple random sampling was used. A structured questionnaire with a four-point rating scale was used for data collection. Data obtained were analyzed using mean and standard deviation to answer the research questions. The major findings were (i) lack of digital skills, inadequate access to technology resources, lack of training and lack of functional technology resources, are factors that resist teachers' to use educational communications technology.(ii) adopting technology in the different operations of the institution, sponsorship of teachers' to workshop, seminar and conferences and are administrative strategies that can be used to encourage the teachers' to use educational communication technology as rated by teachers' in State owned tertiary institutions in Enugu State, Nigeria.

As in the preceding research, this study relates with the present study only for the fact that they both examine the technological aspect of education, in this case, educational communication technology. Every other issue found in the current work remains a gap in the other research.

Nwachukwu and Falode (2019) investigated the self-efficacy and level of preparedness of pre-service teachers for electronic teaching in Niger State, Nigeria. Descriptive survey research design was employed and pre-service teachers in tertiary institutions in Niger State were used as research sample. Four research questions guided the study and a 20-item questionnaire was used as instrument for data collection. The questionnaire was validated by educational technology experts. Pilot test was carried out and reliability coefficients of 0.84 and 0.87 were respectively obtained for the two sections of the questionnaire. Data collected from the administration of the research instruments were analyzed using descriptive statistics of Mean and Standard Deviation. Findings revealed that pre-service teachers have high level of efficacy in using electronic resources for teaching with grand mean score of 3.96. Also, pre-service teachers' response indicated that they are well prepared to use electronic resources for teaching with a grand mean score of 4.35. The reviewed study is equally about electronic teaching, accordingly related to the present study. The former is however about pre-service teachers in contradistinction to the latter's virtual technology teaching generally as it is carried out on senior secondary students of mathematics.

Akinoso and Ajayi (2021) investigated the effect of computer-based instructional strategy on senior secondary school students' achievement and interest in Mathematics. The study adopted a quasi-experimental pretest–posttest control group design. The population comprised all SS II students in public secondary schools in Oyo State, Nigeria, from which 180 students were sampled using multistage sampling technique. Mathematics Achievement Test (MAT) and Mathematics Interest Inventory (MII) were used for data collection. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at 0.05 level of significance. The findings revealed that students taught using computer-based instruction performed significantly better and showed higher interest than those taught using the conventional method. This study relates to the present research because both examined technology-enhanced teaching and students' achievement and interest in Mathematics. However, while Akinoso and Ajayi focused on computer-based instruction in Oyo State, the current study emphasizes virtual technology teaching strategy among senior secondary school students in FCT, Abuja, with particular attention to interest and achievement outcomes.

Ayodeji (2021) conducted a research to examine the effects of multimedia instructional strategy on senior school students' performance and retention in mathematics in Ilorin, Kwara State, Nigeria. The study was a quasi-experimental type of the pre-test, post-test, non- randomized, control group design. The design is a 2x2×1 factorial design. A sample of 81 senior secondary school II students

from two secondary schools in Ilorin south local government area of Kwara State was involved. The research instruments were; developed multimedia instructional package. The experimental group was taught using multimedia instructional strategy, while the control group was exposed to the conventional teaching. Data collected for analysis were subjected to ANCOVA and t-Test statistics. From the study, findings showed that: (1) there was a significant difference between the experimental groups taught mathematics using multimedia and the control group taught mathematics using conventional method (2) both female and male students were capable of competing in classroom activities when taught with a better instructional strategy (3) multimedia instructional strategy improve and stimulate students' retention level thus, multimedia instructional package helps to concretize the learning of mathematics and makes learning more effective. The reviewed study is related to the present study, as both compare students exposed to virtual technology-based instruction with those taught using the teacher-centred method. But this author considers a multimedia approach, and with two research areas of Ilorin, Kwara State, and Bwari, FCT, something new is expected from the current study.

Saniyyati et al. (2021) worked on an article that studied the students' acceptance and interest in the use of VR in learning Mathematics. This study involves 37 students, of whom are 15 male students and 22 female students with age range of 15 and 16 years from Sekolah Menengah Maahad Tahfiz Ilmuan (SMITIN) located in Bangi, Selangor. The module that contains 13 questions and

1 set of questionnaires is used to collect the research data. The findings reveal that majority of the students show good results in the use of VR as learning tools in the lesson, whereby 89% of them got grade A in the task whilst the rest of them got grade A-. These technologies have a positive impact on the students in understanding Mathematics. Furthermore, the findings show that the usage of VR in the group can not only help improve students' social skills in doing tutorial in the class but also increase their interests in learning Mathematics. The implementation of VR application has a positive impact on the students in learning Mathematics with the help of their teachers and parents. Nevertheless, parents need to control the usage of the gadgets. The reviewed study is similar in some respects to the present one as both investigate virtual technology. But while the former concentrates on students' acceptance and interest in the use of VR in learning mathematics, the latter focuses on virtual technology teaching strategy in mathematics.

Salami et al. (2022) examined the effects of virtual classroom instruction on secondary school students' achievement in Mathematics in Kwara State, Nigeria. The study employed a quasi-experimental design involving 120 SS II students selected from four public secondary schools. The instrument used was a Mathematics Achievement Test, and data were analyzed using mean, standard deviation, and ANCOVA. Results showed that students exposed to virtual classroom instruction achieved significantly higher scores than those taught using traditional face-to-face methods. This study is related to the present

research as both investigated virtual-based instructional approaches in Mathematics. Nevertheless, Salami et al.'s study focused solely on achievement without considering students' interest, whereas the present study examines both interest and achievement using a broader virtual technology teaching strategy within the FCT, Abuja context.

Keller et al. (2023) explored the impact of immersive digital learning environments on high school students' engagement and mathematics performance in the United States. A mixed-methods design was adopted, involving 214 students from urban public schools. Data were collected using standardized mathematics tests and student engagement questionnaires. Descriptive statistics and multiple regression analysis were used for data analysis. The findings indicated that immersive digital and virtual tools significantly improved students' engagement and mathematics achievement, with engagement mediating achievement gains. This study is similar to the present research in its emphasis on virtual technology and mathematics learning outcomes. However, while Keller et al.'s study was conducted in a developed country using immersive digital environments and mixed methods, the current research is situated in Nigeria and focuses specifically on virtual technology teaching strategy and its effects on interest and achievement among senior secondary school students in FCT, Abuja.

Cetintav and Yilmaz (2023) investigated the effect of augmented reality technology on middle school students' mathematics achievement, self-regulated

learning skills, and motivation in Türkiye. The study adopted a pretest-posttest quasi-experimental design involving middle school students who were exposed to augmented reality applications during geometry instruction. Data were collected using Mathematics Achievement Test, Motivation Scale, and Self-Regulated Learning Skills Scale. Mean scores and Analysis of Covariance (ANCOVA) were employed for data analysis. Findings revealed that augmented reality significantly improved students' academic achievement and motivation. The study is related to the present study because both studies focused on technology-based instructional strategies and examined students' achievement in mathematics. However, the previous study used augmented reality and investigated motivation and self-regulated learning skills among middle school students in Türkiye, whereas the current study focuses on virtual technology teaching strategy and examines students' interest and achievement among senior secondary school students in the Federal Capital Territory, Abuja. The difference in variables, educational level, and location constitutes the gap addressed by the present study.

Sam-Kayode (2023) investigated Virtual Learning and Undergraduate Students' Academic Achievement in Mathematics during Covid-19 Lockdown in Ibadan, Oyo State. The study adopted One-group pretest-posttest Quasi-Experimental design. The population for this study was two hundred and eighty (280) First-year students in the faculty of Basic Medical and Applied Science, Lead City University, Ibadan, Nigeria. Sample for the study comprised Fifty (50)

students who participated in the virtual learning in Applied Mathematics coded MTH 112 during COVID-19 Lockdown. The instrument for the study was Forty (40) objective questions optioned A to D on Applied Mathematics Achievement Test (AMAT). The instrument was validated and tested for reliability with reliability coefficients of 0.71. Student t-test statistics was used to test the Hypotheses generated at 0.05 level of significance. Hypothesis one revealed a significant difference in the achievement of students in Applied Mathematics when exposed to virtual learning, t-calculated (21.328) was greater than t-table (1.985). Hypothesis two also revealed a significant difference in the achievement of male and female students in Applied Mathematics in favour of male students, t-calculated (20.050) was higher than t-table (2.011). This infers that the male students achieved better than female students in AMAT when exposed to virtual learning. The study concluded that, Virtual learning encourages students' achievement in Applied Mathematics. All the above works have been reviewed with similarities and differences spelt out. The differences suggest gaps; something yet to be addressed. Even in Sam-Kayode (2023)'s Virtual Learning and Undergraduate Students' Academic Achievement in Mathematics during COVID-19 Lockdown in Ibadan, Oyo State, which seems to be the most similar work, differences are still observed in terms of population, area, and situation of study which project different findings at the end of the current study.

Awofala and Uwajuwa (2023) investigated Computer-Assisted Instruction and Mastery Learning Strategy as determinants of senior secondary school

students' achievement in mathematics in Nigeria. The study adopted a quasi-experimental pretest-posttest non-equivalent control group design. A sample of 350 male and female students participated in the study. Mathematics Achievement Test (MAT) was used for data collection, while mean scores, standard deviation, and Analysis of Covariance (ANCOVA) were employed for data analysis. The findings revealed that Computer-Assisted Instruction significantly improved students' achievement in mathematics. The study is similar to the current study because both studies emphasized technology-driven instructional strategies and focused on senior secondary school mathematics achievement. However, the previous study concentrated only on achievement and employed Computer-Assisted Instruction and Mastery Learning Strategy, whereas the present study examines virtual technology teaching strategy and considers both students' interest and achievement. In addition, the present study is specifically delimited to secondary schools in the Federal Capital Territory, Abuja, thereby filling the geographical and variable gaps left by the earlier study.

Egara and Mosimege (2024) examined the effect of the flipped classroom learning approach on secondary school students' mathematics achievement and interest. The study adopted a quasi-experimental pretest-posttest control group design. Secondary school students participated in the study and were assigned to experimental and control groups. Mathematics Achievement Test and Mathematics Interest Inventory were used as instruments for data collection. Mean scores and Analysis of Covariance (ANCOVA) were employed for data

analysis. The findings showed that the flipped classroom approach significantly enhanced students' mathematics achievement and interest. The study is related to the current study because both studies investigated the influence of technology-supported instructional approaches on students' interest and achievement in mathematics. Nevertheless, the previous study focused on the flipped classroom strategy, while the present study investigates virtual technology teaching strategy. Furthermore, the earlier study was conducted outside Nigeria, whereas the present study is situated in the Federal Capital Territory, Abuja. These differences in instructional approach and location provide a gap for the current investigation.

Adebayo and Mohammed (2024) investigated the effects of blended virtual learning strategy on senior secondary school students' interest and achievement in Mathematics in Lagos State, Nigeria. The study adopted a quasi-experimental design with a sample of 150 SS II students selected from six public secondary schools. The instruments used were Mathematics Achievement Test and Mathematics Interest Scale. Mean, standard deviation, and ANCOVA were used for data analysis. The findings revealed that students taught using blended virtual learning strategy demonstrated significantly higher achievement and interest than those taught using conventional teaching methods. This study is closely related to the present research because both examined virtual-based instructional strategies and their effects on students' interest and achievement in Mathematics. However, while Adebayo and Mohammed focused on blended

virtual learning in Lagos State, the present study concentrates on virtual technology teaching strategy among senior secondary school students in FCT, Abuja, thereby extending the literature to a different geographical and educational context.

Anaduaka, Ojelade and Wahab (2025) investigated the impacts of multimedia technology instruction on public secondary school students' motivation and achievement in Mathematics in the Federal Capital Territory (FCT), Abuja, Nigeria. The study adopted a quasi-experimental pretest–posttest control group design. The population consisted of senior secondary school students in public schools within FCT, from which a sample of 160 SS II students was selected using a multistage sampling technique. The instruments used for data collection were a Mathematics Achievement Test (MAT) and a Mathematics Motivation Scale (MMS). Mean rank, mean and standard deviation were used to answer the research questions, while Mann-Whitney U test and Analysis of Covariance (ANCOVA) were employed to test the hypotheses at 0.05 level of significance. The findings revealed that students exposed to multimedia technology instruction demonstrated significantly higher motivation and achievement in Mathematics than those taught using the conventional method. This study is related to the present research because both focus on technology-enhanced instructional strategies and their effects on students' affective and cognitive learning outcomes in Mathematics within the same geographical context (FCT, Abuja). However, while Anaduaka et al. emphasized

multimedia technology instruction and examined motivation and achievement, the present study focuses specifically on virtual technology teaching strategy and extends the affective domain to students' interest, thereby providing a more targeted investigation of virtual technology and its effects on senior secondary school students' interest and achievement in Mathematics.

2.5 Summary

This chapter started with the conceptual framework. The conceptual framework was diagrammatically presented and relationships between the variables were clearly explained. Other concepts related to the study such as the concepts of Mathematics, virtual technology teaching strategy, interest, achievement and gender were clarified. This chapter also adopted John Dewey's (1933) and Atkinson's Cognitive Information Processing (1968) theories as the theoretical framework for this study. The tenet of the theories were discussed and their relationship with the present study were established.

Review of previous empirical studies revealed that technology-based instructional strategies have generally improved students' interest and achievement across different subjects, educational levels, and geographical locations. The similarities and differences between the reviewed studies and the present study were identified in terms of variables investigated, instructional strategies employed, research settings, and participants involved. Although previous studies have examined the effects of technological innovations such as augmented reality, flipped classroom approach, computer-assisted instruction,

and other digital learning strategies on students' academic outcomes, most of these studies were conducted outside the Federal Capital Territory, Abuja, or focused on different subjects and educational levels. In addition, some of the studies concentrated solely on students' achievement without considering students' interest, while others investigated variables such as motivation and self-regulated learning rather than interest. Consequently, empirical evidence on the combined effects of Virtual Technology Teaching Strategy (VTTS) on both students' interest and achievement in Mathematics among senior secondary school students in the Federal Capital Territory, Abuja, is either scanty or non-existent. Therefore, the present study seeks to fill these geographical, contextual, methodological, and variable gaps by providing empirical evidence on the effectiveness of VTTS in enhancing senior secondary school students' interest and achievement in Mathematics in the FCT, Abuja, Nigeria.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This chapter describes the research methodology used in conducting the research. It involves discussion on the research design, population of the study, sample size and sampling procedure, instrumentation, validity and reliability of the instruments, data collection procedure and method of data analysis.

3.2 Research Design

The research design for this study was a quasi-experimental non-randomised control group research design adopting the pretest and posttest control group type. A quasi-experimental research design is justified when random assignment of participants to groups is not feasible, yet the researcher seeks to examine causal relationships through the use of existing or intact groups. The pretest was conducted to test the entry behaviour of both control and experimental groups, while the posttest was administered after treatment to find out the effect of the treatment. The treatment of the research was the use of virtual technology teaching strategy for teaching the experimental group, and using the conventional method of teaching for teaching the control group.

The research design is diagrammatically expressed as:

$EG = O_1 \rightarrow X_1 \rightarrow O_2$

$CG = O_1 \rightarrow X_0 \rightarrow O_2$

Where:

EG= Experimental Group

CG= Control Group

O_1= Pretest for both EG and CG

O_2= Posttest for both EG and CG

X_1 = Treatment for EG (virtual technology teaching strategy)

X_0 = Conventional Lecture Method for CG

(Martyn, 2016)

3.3 Population of the Study

The population of the study comprised all SS II students in public senior secondary schools in Federal Capital Territory, Abuja. There are eighty-eight (88) public senior secondary schools in FCT, Abuja with a population of nine thousand eight hundred and eighty-seven (9,887) SS II students. Among this is four thousand one hundred and seventeen (4,117) male and five thousand seven hundred and seventy (5,770) female students. This is presented in Table 1.

Table 1: Population of SS II Students in FCT

S/N	Area Council	No. of School	Population	Male	Female
1	Abaji	10	1123	563	560
2	AMAC	30	3370	1185	2185
3	Bwari	13	1438	601	837
4	Gwagwalada	13	1491	611	880
5	Kuje	13	1453	636	817
6	Kwali	9	1012	521	491
	Total	**88**	**9887**	**4117**	**5770**

Source: FCT Secondary Education Board (2025)

3.4 Sample Size and Sampling Techniques

A sample size of 120 Senior Secondary School II (SS II) students constituted the sample for this study. The population comprised students from the 13 co-educational public secondary schools in Bwari Area Council, Federal Capital Territory (FCT), Abuja. Using the simple random sampling technique, two (2) co-educational schools were selected from the thirteen schools to ensure that each school had an equal chance of being included in the study, thereby minimizing selection bias. Following the selection, one school was randomly assigned to the experimental group, while the other served as the control group. The use of separate schools for the two groups helped to prevent treatment contamination and interaction effects that could arise if students within the same school were exposed to different instructional approaches.

Since intact classes are naturally existing groups that cannot be reorganized without disrupting normal school activities, one SS II intact Mathematics class from each selected school was used for the study. Consequently, all students in the selected intact classes participated, giving a total sample size of 120 students. The experimental group was exposed to the Virtual Technology Teaching Strategy (VTTS), while the control group was taught using the conventional teaching method. The sample size consisted of one hundred and twenty (120) SS II students, 70 for experimental group and 50 for control group. This is presented in Table 2.

Table 2: Sample Size of the Study

S/N	Name of School	Group	Male	Female	Total
1	GDSS Bwari	Experimental	44	26	70
2	GSS Ushafa	Control	30	20	50
	Total		**74**	**46**	**120**

3.5 Instrumentation

Two instruments were constructed for the study. These are: Mathematics Achievement Test (MAT), and Mathematics Interest Scale (MIS). The Mathematics Achievement Test (MAT) consists of 20 multiple choice questions, with four options (A, B, C, D) of which one is the only correct option. It was developed by the researcher using basic procedures of constructing a test with the aid of a Table of Specification (the Table of Specification is shown in Appendix D), which is developed from the content taught to both the experimental and control groups. The contents are Change of subject of the formula, Right-angled triangle, Quadratic equation, linear inequality, Logarithms, Algebraic Fractions etc, which are contents of SS2 mathematics for the term the study was conducted. The Mathematics Achievement Test (MAT) and its marking scheme is shown in Appendix B.

Mathematics Interest Scale (MIS) on the other hand consists of twenty (20) items developed by the researcher and designed to assess students' interest in Mathematics. The instrument is on four-point modified likert scale format of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) and

were scored as: SA = 4, A = 3, D = 2 and SD = 1. The Mathematics Interest Scale (MIS) instrument is shown in Appendix B.

3.6 Validity and Reliability of the Instruments

An instrument is valid when it is able to measure what it is designed to measure. In order to make the instruments of this study valid, the two instruments were subjected to both face and content validities. Mathematics Achievement Test (MAT) was constructed based on specifications on a Test Blue Print to ensure its content validity. Both MAT and MIS were then validated by two experts from Department of Science and Environmental Education, University of Abuja. The experts observed that some items contained ambiguous expressions and technical terms that might be difficult for the students to understand. They also recommended the rewording of a few items to improve clarity and ensure that each item measured only one concept. In addition, some distracters in the Mathematics Achievement Test were considered too obvious and were subsequently modified to make them more plausible. The arrangement and numbering of some items were also adjusted for better organization and ease of administration. Furthermore, minor grammatical and typographical errors identified in the instruments were corrected. Based on these observations, necessary corrections and modifications were effected by the researcher before the final administration of the instruments. All the items were found to be relevant to the objectives of the study and adequately represented the content areas covered. Consequently, no item was discarded after the validation exercise;

rather, all items survived the validation process after the recommended revisions had been incorporated. The validated instruments were thereafter used for data collection.

A pilot test was conducted to establish the reliability of the instruments. The validated Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) Questionnaire were administered to a group of thirty (30) SS II students who were part of the population but not included in the main sample of the study. The pilot participants possessed similar characteristics to those of the respondents used for the actual study. The Mathematics Achievement Test (MAT) was administered first, followed by the Mathematics Interest Scale (MIS) Questionnaire. During the pilot testing, the time taken by the students to complete the instruments was observed and recorded. It was discovered that the majority of the students completed the MAT within approximately 25 minutes, while a few required slightly more time. Consequently, 30 minutes were considered adequate and allotted for the administration of the MAT to ensure that all students had sufficient time to respond to the test items without undue pressure.

Similarly, the responses obtained during the pilot study revealed that the students completed the Mathematics Interest Scale (MIS) Questionnaire within a short period. Since most of the students finished within about 8 minutes, an additional margin was provided and a total of 10 minutes was allotted for the completion of the questionnaire. The time allocations were therefore based on

the average completion time observed during the pilot testing and were considered adequate for effective administration of the instruments. The data collected were subjected to Kuder-Richardson 21 formula for MAT and Cronbach alpha probability technique for MIS to determine their reliability. The reliability indices of 0.79 and 0.84 were obtained respectively (See Appendix E).

3.7 Data Collection Procedure

A letter of introduction was collected from the Department (See Appendix A) as part of the procedure for data collection. The letter was taken to the schools concerned. Mathematics teachers in the study school served as the research assistants. The teacher in the experimental school was trained by the researcher for two hours daily over one week on how to use virtual technology to teach Mathematics (see Appendix F for the training manual), while the teacher in the control school taught the students using the conventional method to which they were accustomed. The Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) were administered to both the experimental and control groups as pretests to determine the entry behaviour and establish the baseline equivalence of the two groups before the commencement of treatment. Following the pretest administration, the experimental group was taught Mathematics concepts using the Virtual Technology Teaching Strategy (VTTS), which involved the use of virtual technological resources to facilitate interactive and learner-centred instruction. In contrast, the control group was exposed to the

same Mathematics concepts using the conventional teaching method commonly employed in the schools.

The treatment lasted for eight (8) weeks, during which both groups received instruction according to their normal school timetable and covered the same content. At the end of the treatment period, the Mathematics Achievement Test (MAT) was re-administered to both groups as a posttest to determine the effect of the treatment on students' achievement. Thereafter, the Mathematics Interest Scale (MIS) was distributed to the students in both groups to assess their level of interest in Mathematics after exposure to the respective instructional strategies. The completed questionnaires were collected on the same day of administration. The pretest and posttest scores obtained from both the experimental and control groups were carefully recorded and used for data analysis.

3.8 Method of Data Analysis

The collected data were analysed using descriptive statistics of mean rank, mean and standard deviation to answer the research questions while Mann-Whitney U test and ANCOVA (inferential statistics) were used to test the hypotheses formulated for the study at 0.05 level of significance. The Statistical Package for Social Science (SPSS) version 25 was used to analyse the data.

CHAPTER FOUR

4.0 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter deals with presentation of data, analysis and interpretation, summary of findings and discussion of findings.

4.2 Presentation of Data

Data were presented, analysed and interpreted based on the research questions and hypotheses. The decision rule for the null hypotheses was that if the p-value is less than 0.05 ($p<0.05$), the null hypotheses were rejected. On the other hand, if the p-value is greater than 0.05 ($p>0.05$), the null hypotheses were not rejected.

4.3 Data Analysis and Results

The analysis of the data according to the research questions and test of hypotheses are as follows:

Research Question One: What is the difference between the mean rank interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using Conventional Method?

Table 3: Mean Rank and Sum of Ranks of Interest Scores of Experimental and Control Group

Group	N	Mean Rank		Sum of Ranks	
		Pretest	Posttest	Pretest	Posttest
Experimental	70	44.57	64.85	2044.500	2517.500
Control	50	38.92	39.77	1836.500	1754.500
Mean Rank Difference		**5.65**	**25.08**		
Total	**120**				

Table 3 shows the mean rank and sum of ranks of interest scores of students in the experimental and control group before (Pretest) and after (Posttest) the treatment. The results indicate a significant positive impact of Virtual Technology Teaching Strategy (VTTS) on students' interest towards Mathematics. The mean rank of the experimental group increased from 44.57 to 64.85 while the control group's mean rank slightly increase from 38.92 to 39.77. The difference in mean rank between the two groups increased from 5.65 to 25.08, suggesting a widening gap in favour of the experimental group. The sum of ranks for the experimental group also increased significantly from 2044.500 to 2517.500 while the control group's sum of ranks decreased slightly from 1836.500 to 1754.500.

Research Question Two: What is the difference between the mean achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?

Table 4: Mean Achievement Scores of Students in Experimental and Control Group

Group		**Pretest**		**Posttest**		**Mean gain**
	N	$\bar{x}$	**SD**	$\bar{x}$	**SD**	
Experimental	70	31.55	4.842	55.94	6.716	**24.39**
Control	50	30.89	4.795	38.92	5.098	**8.03**
Mean Difference		**0.66**		**17.02**		

In Table 4, the mean achievement scores of students taught Mathematics using Virtual Technology Teaching Strategy (VTTS) is 31.55 and 55.94 for the pretest and posttest respectively, and mean gain score is 24.39 while the mean

achievement scores of students taught Mathematics using conventional teaching method is 30.89 and 38.92 for the pretest and posttest respectively and mean gain score is 8.03. Also, the mean difference for the posttest is 17.02 in favour of the experimental group. This indicated that students taught Mathematics using VTTS achieved higher than those taught Mathematics using conventional teaching method in senior Secondary Schools Abuja, Nigeria.

Research Question Three: What is the difference between the mean rank interest scores of male and female senior secondary school students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

Table 5: Mean Rank and Sum of Ranks of Interest Scores of Male and Female Students taught with VTTS

Group	N	Mean Rank	Sum of Ranks
Male	44	27.97	656.00
Female	26	25.88	599.00
Mean Rank Difference		2.09	
Total	**70**		

Table 5 reveals the mean rank and sum of ranks of interest scores of male and female students taught Mathematics using VTTS. The sample consisted of 44 male and 26 female students. The mean rank for male students was 27.97 with a sum of ranks of 656.00. The mean rank for female students was 25.88 with a sum of ranks of 599.00. Therefore, the mean rank difference in interest score between male and female students in experimental group is 2.09 in favour of male students.

Research Question Four: What is the difference between the mean achievement scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

Table 6: Means Achievement Scores of Male and Female Students taught Mathematics using VTTS

Groups	N	Mean	Standard Deviation
Male	44	48.27	8.53
Female	26	47.61	7.72
Difference		**0.66**	

The result in Table 6 shows the mean achievement scores of male and female students taught Mathematics using VTTS as the male students had a mean achievement score of 48.27 with a standard deviation of 8.53, while the female students had a mean achievement score of 47.61 with a standard deviation of 7.72. Due to the comparative low difference in the means achievement scores of the two groups, this indicated that the means achievement scores of male and female students was not influenced by students' gender.

Test of Hypotheses

Hypothesis One: There is no significant difference between the mean rank interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional teaching method in the FCT, Abuja.

Table 7: Mann-Whitney U Test of Interest Scores of Experimental and Control Group

Test Statistics[a]	INTEREST
Mann-Whitney U	685.000
Wilcoxon W	2428.000
Z	-2.145
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Teaching Methods

Table 7 reveals Mann-Whitney U test of interest scores of students taught Mathematics using VTTS and those taught using conventional teaching method. The results indicate a statistically significant difference between the interest scores of experimental and control groups ($z = -2.145$; $p < .05$). This implies that there is significant difference between the mean interest scores of students in the experimental and control group in senior secondary schools in the FCT, Abuja.

Hypothesis Two: There is no significant difference between the mean achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional teaching method in the FCT, Abuja.

Table 8: **Analysis of Covariance (ANCOVA) of Respondents' Scores in Mathematics Achievement Test (Method)**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4214.443[a]	2	2107.222	225.840	.000	.794
Intercept	686.568	1	686.568	73.582	.000	.386
Pretest	2357.098	1	2357.098	252.620	.000	.683
Group	30.163	1	30.163	3.233	.002	.027
Error	1091.682	117	9.331			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .794 (Adjusted R Squared = .791)

The result in Table 8 shows that $F_{(1,117)} = 9.331$; Sig = 0.002 < 0.05. This significant value of 0.002 is less than the alpha value of 0.05 level of significance. Hence, the null hypothesis was not accepted. This implies that there is statistically significant difference in the Mathematics achievement mean scores of students in the experimental and control group. It therefore implies that the mean achievement scores of students in Mathematics do differ significantly between the experimental and the control group in favour of experimental group.

Hypothesis Three: There is no significant difference between the mean interest scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria.

Table 9: Summary of Mann-Whitney U Test Results of Interest Score of Students taught Mathematics Using VTTS

Groups	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Sig.	Remark
Male	44	27.97	656.00	325.000	-1.216	.494	Not Sig.
Female	26	25.88	599.00				

Table 9 summarizes the results of Mann-Whitney U test conducted to compare the interest scores of male and female students in experimental group. The results of Mann-Whitney U test yielded no statistically significant difference between the two variables ($z = -1.216$; $p > .05$). Therefore, null hypothesis three is accepted. This implies that there is no significant difference between male and female students' interest mean rank score in mathematics who were taught using virtual technology teaching strategy in senior secondary schools in the FCT Abuja, Nigeria.

Hypothesis Four: There is no significant difference between the mean achievement scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in the FCT Abuja, Nigeria.

Table 10: **Analysis of Covariance (ANCOVA) of Respondents' Scores in Mathematics Achievement Test (Gender)**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4200.685[a]	2	2100.342	222.301	.000	.792
Intercept	725.230	1	725.230	76.758	.000	.396
Pretest	2909.474	1	2909.474	307.939	.000	.725
Gender	16.404	1	16.404	1.736	.190	.015
Error	1105.440	117	9.448			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .792 (Adjusted R Squared = .788)

The result in Table 10 shows that $F_{(1,117)} = 1.736$; Sig = 0.190 > 0.05. This significant value of 0.190 is greater than the alpha value of 0.05 level of significance. Hence, the null hypothesis which states that there is no significant difference between male and female students' achievement score in Mathematics who were taught using virtual technology teaching strategy in senior secondary schools in FCT Abuja was not rejected. Thus, it indicates that there was no significant difference in the mean achievement scores of male and female students taught Mathematics using the virtual technology teaching strategy.

4.4 Summary of Findings

The following are the summary of findings of this study:

i. There was statistically significant difference between the mean rank interest scores of students in the experimental and control group in senior secondary school, Abuja in favour of experimental group.

ii. There was statistically significant difference in the Mathematics achievement scores of students in the experimental and control group in favour of experimental group.

iii. There was no significant mean rank difference between male and female students' interest mean score in experimental group.

iv. There was no significant difference in the mean achievement scores of male and female students taught Mathematics using virtual technology teaching strategy.

4.5 Discussion of Findings

This study investigated the effects of virtual technology teaching strategy on senior secondary students' interest and achievement in mathematics in FCT Abuja, Nigeria. The discussion of findings was done based on the variables examined in the study which were guided by the research questions asked and hypotheses formulated.

The first finding of the study revealed that there was a significant difference in the mean interest scores of students in the experimental and control groups in favour of experimental group. This finding is consistent with the study of Radianti et al. (2020), which reported that virtual reality–based instruction significantly enhanced students' interest and engagement as well as their conceptual understanding in science-related subjects when compared with conventional teaching methods using a quasi-experimental design. The result revealed that the virtual reality-based instruction is superior to the teacher-

centered method in fostering conceptual Performance and interest among the students. The study also found that there was a significant mean difference between pretest and posttest interest scores. This finding also agrees with that of Ityavzua (2019) who worked on the effect of virtual mathematics laboratory on senior secondary school student's interest in circle geometry in north-central geopolitical zone, Nigeria and found that that type of mathematics laboratory had significant effect on students' interest in circle geometry. Students taught circle geometry using Virtual Mathematics Laboratory had significant higher interest in circle geometry than those taught with Traditional Mathematics Laboratory. This finding however, disagrees with that of Fabian, Topping and Barron (2018) whose investigation on the effects of using mobile technologies to students' attitudes and achievement Students' attitude to mathematics, as assessed by a mathematics attitude inventory, found that there was no significant change for both groups except for the significant decline in enjoyment for the control group.

The significant improvement in students' interest observed in this study could be attributed to the unique characteristics of the Virtual Technology Teaching Strategy. The strategy provides an interactive and learner-centred environment that actively involves students in the learning process rather than making them passive recipients of knowledge. Through the use of visual representations, simulations, and virtual learning experiences, abstract mathematical concepts become more concrete, meaningful, and easier to

understand. In addition, the engaging and immersive nature of virtual technology stimulates students' curiosity, sustains their attention, and promotes active participation during instruction. These features are capable of making mathematics lessons more enjoyable and motivating, thereby enhancing students' interest in the subject.

The second finding made by this study revealed that there was significant difference in the mean achievement scores of Mathematics students in the experimental and control group. This finding contrasts with the meta-analytic evidence reported by Makransky et al. (2021), which indicated that while virtual reality-based learning environments often enhance students' engagement and motivation, they do not consistently produce significantly higher achievement outcomes when compared with conventional instructional approaches, particularly when cognitive load is not adequately managed. This finding however, agrees with the earlier finding made by Sam-Kayode (2023) who investigated Virtual Learning and Undergraduate Students' Academic Achievement in Mathematics during Covid-19 Lockdown in Ibadan, Oyo State, and revealed that there was a significant difference in the achievement of students in Applied Mathematics when exposed to virtual learning. The study also found that there was a significant difference in the achievement score of undergraduate students of those in the experimental and control group.

The significant improvement in achievement recorded in this study may be attributed to the inherent features of the Virtual Technology Teaching

Strategy. The strategy provides students with interactive and visually rich learning experiences that facilitate better understanding of abstract mathematical concepts. By incorporating animations, simulations, and virtual representations, students are able to visualize relationships among mathematical ideas and actively participate in the learning process. Furthermore, the learner-centred nature of the strategy encourages exploration, immediate feedback, and sustained engagement, which enhance comprehension and retention of concepts. Unlike the conventional method that often emphasizes passive learning, the Virtual Technology Teaching Strategy promotes meaningful learning experiences that enable students to construct knowledge more effectively, thereby leading to improved academic achievement in Mathematics.

The third finding of this study showed that there was no significant difference in the mean interest scores of Mathematics students taught using virtual technology teaching strategy across Gender. This finding agrees with that of Ityavzua (2019) work on the effect of Virtual Mathematics Laboratory (VML) on senior secondary school students' interest in circle geometry in north-central geopolitical zone, Nigeria, which revealed that gender did not significantly influence students' interest in the teaching of circle geometry using Virtual Mathematics Laboratory. It was also revealed from this study that type of mathematics laboratory and gender had no significant interaction effect on students' interest in circle geometry. However, this finding contradicts the study by Radianti et al. (2020), who reported that virtual reality-based instructional

environments significantly enhanced learners' interest and engagement, with evidence that learner characteristics, including gender, could moderate the affective outcomes of immersive learning experiences.

The absence of a significant gender difference in students' interest could be attributed to the inclusive and learner-centred nature of the Virtual Technology Teaching Strategy. The strategy provides equal access to learning resources and opportunities for active participation irrespective of gender. Through interactive simulations, visual representations, and collaborative learning experiences, both male and female students are exposed to the same learning environment and are equally engaged in the instructional process. Since virtual technology emphasizes exploration, interaction, and self-paced learning rather than gender-based roles or stereotypes, it creates a supportive environment that stimulates interest among all learners. Consequently, the strategy was able to foster similar levels of interest in Mathematics among both male and female students.

The last finding made by this study revealed that there was no significant difference in the mean achievement scores of Mathematics students taught using Virtual Technology Teaching Strategy across gender. This finding agrees with that of Awofala and Uwajuwa (2023), whose investigation into the effects of Computer-Assisted Instruction and Mastery Learning Strategy on senior secondary school students' achievement in Mathematics revealed that gender had no significant influence on students' achievement. The study showed that both

male and female students benefited equally from the technology-based instructional approach, indicating that academic performance is determined more by the effectiveness of the instructional strategy than by gender differences. Similarly, Cetintav and Yilmaz (2023) found that technology-supported learning environments enhanced students' academic outcomes irrespective of gender, suggesting that both male and female learners can perform equally well when exposed to engaging and interactive instructional experiences. On the contrary, this finding disagrees with that of Sam-Kayode (2023), whose investigation on Virtual Learning and undergraduate students' academic achievement in Mathematics during the COVID-19 lockdown in Ibadan, Oyo State revealed a significant difference in the achievement of male and female students taught Applied Mathematics using virtual learning. The study indicated that male students achieved better than their female counterparts in the Applied Mathematics Achievement Test (AMAT) when exposed to virtual learning.

The absence of a significant gender difference in achievement observed in this study may be attributed to the equitable and interactive nature of the Virtual Technology Teaching Strategy. The strategy provides identical learning opportunities, instructional resources, and experiences for both male and female students. Through the use of simulations, visual illustrations, and learner-centred activities, students are encouraged to actively construct knowledge at their own pace without being limited by gender stereotypes. In addition, virtual technology

promotes collaboration, immediate feedback, and active engagement, which enable both male and female students to develop similar levels of understanding and mastery of mathematical concepts. Consequently, achievement in Mathematics under the Virtual Technology Teaching Strategy appears to depend more on students' level of participation and exposure to the instructional process than on gender differences.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study, conclusion, implications of the study, limitation to the study, recommendations, contributions to knowledge and suggestions for further studies.

5.2 Summary

This study investigated the effects of virtual technology teaching strategy on senior secondary students' interest and achievement in Mathematics in the Federal Capital Territory, Abuja. The study was guided by four objectives which were translated to four research questions. Four null hypotheses were tested at 0.05 level of significance. The study further examined the related literature relevant to the study as well as empirical review of previous studies conducted by other scholars in the field. The theoretical framework for this study was anchored on Constructivism Learning Theory by John Dewey (1933) and Cognitive Information Processing (CIP) Learning Theory by Atkinson (1968).

A quasi-experimental non-randomized control research design adopting pretest and posttest control group was employed for the study. The population of the study comprised of 9887 SS II mathematics students in public senior secondary schools in the FCT, Abuja. A sample size of 120 SS II students, 70 for experimental group and 50 for control group was drawn from the population

using simple random sampling technique which was used for this study. Two instruments titled: Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) were used for this study. Mean rank, Means and standard deviations were used to answer the research questions while Mann-Whitney U test and Analysis of Variance (ANCOVA) were used to test the null hypotheses at 0.05 level of significance. The results of the findings show the effectiveness of Virtual Technology Teaching Strategy on students' interest and achievement in Mathematics and no significant difference was found between male and female students' interest and achievement in the experimental group.

5.3 Conclusion

The findings of this study discovered the effectiveness of the Virtual Technology Teaching Strategy (VTTS) over the conventional teaching method in enhancing students' interest and achievement in Mathematics. The VTTS also proved to be gender-friendly as it enhanced students' interest and achievement equally in mathematics without differences between males and females.

5.4 Implications of the Study

The findings of this study have significant implications for teaching practices and Mathematics education. The higher interest and achievement scores among students in the experimental group underscore the role of teaching methods in shaping students' interest toward learning. These findings call for professional development programmes to equip teachers with skills for implementing Virtual classrooms.

Additionally, the superior achievement of students taught using the Virtual Technology Teaching Strategy (VTTS) confirms that adopting innovative, student-centred teaching approaches can effectively enhance interest and achievement of the students. This underscores the need for educators to integrate strategies that promote active learning, conceptual understanding and engagement.

5.5 Limitations of the Study

The following limitations were recorded during the conduct of this study:

1. The study was also constrained by the relatively short duration of the intervention, which lasted for eight weeks. Although this period was sufficient for observing initial effects of the Virtual Technology Teaching Strategy, it may not adequately capture long-term impacts on students' interest and achievement in Mathematics. A more extended period of exposure could potentially yield more stable and comprehensive results.
2. The use of intact classes also presented a limitation, as students were not randomly assigned individually to experimental and control groups. This may have introduced pre-existing differences between groups, although efforts were made to control for this using pretest scores.
3. The study was also affected by occasional technological constraints. Challenges such as unstable electricity supply, limited device availability, and intermittent connectivity issues may have disrupted the smooth delivery of virtual instruction at certain points during the intervention.

5.6 Recommendations

Based on the findings from the study and the conclusion reached, the following recommendations were made:

1. The virtual technology teaching strategy (VTTS) used in the experimental group should be adopted by the teachers as it appeared to have a positive effect on students' interest in mathematics compared to conventional method used in the control group.
2. Teachers should adopt and integrate the virtual technology teaching strategy more widely in Mathematics classes to improve students' achievement.
3. Mathematics educators should continue using the virtual technology teaching strategy since it engages both male and female students equally, promoting gender-inclusive learning.
4. Stakeholders in education should encourage teachers on the use of virtual technology teaching strategy as an equitable approach that supports balanced achievement outcomes across genders.

5.7 Contribution to Knowledge

This study contributes to knowledge by demonstrating that the use of virtual technology teaching strategy enhanced students' achievement in Mathematics compared to conventional methods, highlighting its effectiveness as an instructional approach. Additionally, the findings show that this strategy promotes gender equity in learning, as there were no significant differences in

interest or achievement between male and female students in the experimental group. These results provide evidence that virtual technology can be a powerful, inclusive tool for improving Mathematics education in senior secondary schools, supporting policy and practice aimed at integrating technology to boost overall learning outcomes.

5.8 Suggestion for Further Studies

1. Comparative study of the effectiveness of virtual and blended learning strategies on students' achievement in Mathematics in senior secondary schools.
2. A study on strategies for improving equitable access to virtual learning technologies among secondary school students in the FCT.
3. An investigation into effective teacher training models for enhancing readiness to implement virtual technology teaching strategies in mathematics.
4. Gender differences in the use of virtual learning tools and their influence on Mathematics anxiety and performance among senior secondary students.

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APPENDIX A

UNIVERSITY OF ABUJA, ABUJA

Faculty of Education

Department of Science and Environmental Education

8th June, 2023

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION

RE: AZENDA, TIMOTHY IKYULAVWASE (REG. NO.: 19/404SEEU/007)

The bearer, **AZENDA, Timothy Ikyulavwase** with **Reg. No.: 19/404SEEU//007** is an M.Ed. Mathematics Education student of this Department.

He is presently undertaking a research project on "***Effect of Virtual Technology on Senior Secondary Students' Interest and Achievement in Mathematics in FCT, Abuja, Nigeria".***

Kindly accord him all the necessary assistance he may require of you.

Thank you.

SCIENCE AND ENVIRONMETAL EDUCATION
UNIVERSITY OF ABUJA

Dr. I. A. Ojelade
Ag. Head of Department

APPENDIX B

Department of Science and,

Environmental Education,

Faculty of Education,

University of Abuja.

Dear Respondent,

INTRODUCTION

I am a Master student working on **"Effects of Virtual Technology Teaching Strategy on Senior Secondary School Students' Interest and Achievement in Mathematics in the Federal Capital Territory Abuja, Nigeria."** You are required to respond to the items therein objectively. Whatever information supplied will be treated only for the purpose of the research. Be reassured of the confidentiality of your identity and response.

Thank you

Ikyulavwase Timothy AZENDA

REG. NO.: 19/404SEEU/007

Mathematics Achievement Test (MAT)

School……

Gender: Male [ ] Female [ ] Class: SS 2

Age…… Time Allowed: 50 Minutes

Instruction: answer all questions by circling the correct option.

1. Make Q the subject of the formula when $L = \frac{4}{3} M\sqrt{PQ}$

   a. $Q = \frac{9L^2}{16M^2 P}$ b. $Q = \frac{3L}{4M\sqrt{P}}$ c. $Q = \frac{\sqrt{3L}}{16M^2 P}$ d. $Q = \frac{3L^2}{16M^2}$ p

2. If $P = \frac{\sqrt{rS^2}}{t}$, express r in term of P, S and t?

   a. $r = \frac{P^2t^2}{S^2}$ b. $r = \frac{P^3t}{S^3}$ c. $r = \frac{P^2t}{S^2}$ d. $r = \frac{Pt}{S^3}$

3. Make Q the subject of the relation $t = \sqrt{(\frac{PQ}{r-r^2Q})}$

   a. $Q = \frac{t^2r}{(P+t^2r^2)}$ b. $Q = \frac{t^2}{(P-r^2)}$ c. $Q = \frac{rt}{(P-r^3)}$ d. $Q = \frac{P-r^3}{rt^2}$

4. Find the area of a rectangle of length 4cm and whose diagonal is 8cm, (leave your answer in surd form).

   a. $8\sqrt{3}cm^2$ b. $12\sqrt{3}cm^2$ c. $16\sqrt{2}cm^2$ d. $16\sqrt{3}cm^2$

5. Make Q the subject of the formula if $P = \frac{M}{5}(X + Q) + 1.$

   a. $\frac{5P-MX+5}{M}$ b. $\frac{5P - MX- 5}{M}$ c. $\frac{5P + MX + 5}{M}$ d. $\frac{5P+ MX- 5}{M}$

6. Make ***u*** the subject in $x = \frac{2u - 3}{3u + 2}$

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

7. A solid brass cube is melted and recast as a cone of height ***h*** and base radius ***r***. If the height of the cube is ***h***, find r in terms of ***h***.

a. r = h b. $r = h\sqrt{\frac{3}{\pi}}$ c. $r = \pi$ d. $r = h\frac{\sqrt{3}}{h}$

8. Given that $r = \frac{\sqrt{3V}}{\pi h}$, make V the subject of the formula.

a. $V = 3\pi r^2 h$ b. $V = \frac{\pi rh}{3}$ c. $V = \frac{\pi^2 r^2 h^2}{3}$ d. $V = 3\pi rh$

9. Make t the subject of $k = m\frac{\sqrt{t-p}}{r}$

a. $t = \frac{k^2 r+p}{m^2}$ b. $t = \frac{pm^2+k^2r^2}{m^2}$ c. $t = \frac{k^2 r-p}{m^2}$ d. $t = \frac{k^2 r+p^2}{m^2}$

10. Make x the subject of the formula: $y = \frac{3x-9c}{4x+5d}$

a. $x = \frac{-(9c-5dy)}{4y-3}$ b. $\frac{9c-5dy}{4y-3}$ c. $x = \frac{9c-5dy}{4y-3}$ d. $x = \frac{5dy+9c}{3-4y}$

11. Suppose the length of the same room is measured to the nearest cm, 280cm i.e. (280cm) calculate the percentage error. (a) 0.168% (b) 0.188% (c) 0.178% (d) 0.701%

12. Find the 6th terms of the sequence whose nth term is (2n + 1) __(a) 12 (b) 11 (c) 13 (d) 15

13. Find the 9th terms of the sequence whose nth term is 3 – 5n. (a) +42 (b) -42 (c) -45 (d) +13

14. A sequence in which the terms either increase or decrease in equal steps is called an___ (a) Set (b) Geometric progression (c) Arithmetic progression (d) Integer

15. Given the A.P, 9, 12, 15, 18 …… find the 50th term. (a) 156 (b) 158 (c) 157 (d) 137

16. A sequence in which the terms either increase or decrease in a common ratio is called a___(a) Set (b) Geometric progression (c) Arithmetic progression (d) Rational

17. Given the GP 5, 10, 20, 40. Find its 9th term. (a) 1280 (b) 1290 (c) 1291 (d) 1270

18. Find two numbers whose difference is 5 and whose product is 266. (a) X=13, X=-19 (b) X=14, X=+19 (c) X=17, X=-19 (d) X=13, X=+19
19. Solve for x and y in the equations 2x +5y= 1 and 3x – 2y =30 (a) y = -3, x =8 (b) y =+3, x=7 (c) y =-3, x=9 (d) y =+3, x=9
20. Seven cups and eight plates cost N1750, eight cups and seven plates cost N1700. Calculate the cost of a cup and a plate. (a) Each cup cost ₦90 and each plate cost ₦120 (b) Each cup cost ₦90 and each plate cost ₦140 (c) Each cup cost ₦40 and each plate cost ₦144 (d) Each cup cost ₦70 and each plate cost ₦134

Marking scheme for MAT

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

Mathematics Interest Scale (MIS)

Dear Respondent,

Gender ----------

School----------

Below is a list of items designed by a post Graduate student to investigate the degree of people's interest on mathematics.

You are requested to freely rate yourself to indicate the degree to which the items are interesting to you. All information you will provide in this exercise will be used strictly for the research exercise only and will be treated under strict confidentiality. Please note this key provided:

Please mark (x) in the appropriate column of your choice

Strongly agreed---------- ----------SA

Agreed---------- ----------A

Disagreed----------D

Strongly Disagreed----------SD

S/N	Item	SA	A	D	SD
1	Going to Mathematics lab for learning activities is boring.				
2	I enjoy doing calculations in mathematics				
3	I am willing to study mathematics related courses in my further studies				
4	I would encourage friends and relatives to study mathematics.				
5	It the study of mathematics useful to our everyday life				
6	Studying mathematics is difficult and				

	waste of time				
7	Using symbols and formulae is boring				
8	I enjoy discussing topics in mathematics with my fellow students.				
9	I feel happy in a mathematics class				
10	I enjoy using my knowledge of virtual technology to understand some mathematics principles				
11	Knowing more about applications of Mathematics to solve personal problem is not my concern.				
12	I find mathematics understandable and abstract subject				
13	The methods employed by my mathematics teachers have made me like mathematics				
14	The methods employed by my mathematics teachers have made me hate mathematics				
15	Using virtual technology in teaching mathematics arouse my interest on mathematics				
16	I hate mathematics because of my friends hate it				
17	Mathematics is for male students and not for female students				
18	Mathematics is for both male and female students				
19	Introduction of virtual technology has made me hate mathematics				
20	Introduction of virtual technology has increase my interest on mathematics				

APPENDIX C

VALIDATION REQUEST LETTER

Department of Science and Environmental Education
Faculty of Education
University of Abuja
24th January, 2025

…….
……..
…….
…….

REQUEST FOR VALIDATION OF MATHEMATICS ACHIEVEMENT TEST (MAT)AND MATHEMATICS INTEREST SCALE (MIS)

I am a postgraduate student of the above mentioned institution undergoing a study on the Effect of virtual technology teaching strategy on senior secondary students' interest and achievement in mathematics in FCT Abuja Nigeria. I solicit for your assistance in validating my research instrument as your professional correction and modification will help to authenticate the instrument. Attached are photocopies of Objectives of the Study, Research Questions, Hypothesis, and the Topics to be covered for the purpose of the study, Mathematics Achievement Test (MAT), Mathematics Interest Scale Questionnaire, and Marking scheme of (MAT).

Yours faithfully,

Timothy Ikyulavwase AZENDA
Reg No: 19/404SEEU/007

APPENDIX D

CONTENTS VALIDATION

TABLE OF ITEMS SPECIFICATION FOR MAT

Topic	**Learning Objectives**						
	Knowledge	**Comprehension**	**Application**	**Analysis**	**Synthesis**	**Evaluation**	**Total**
Right-angled Triangle	1 (Q4)	1 (Q2)	0	0	0	0	**2**
Quadratic Equations	1 (Q3)	0	1 (Q1)	0	1 (Q5)	0	**3**
Linear Inequality	1 (Q6)	1 (Q7)	2 (Q8, Q9)	1 (Q10)	1 (Q11)	0	**6**
Logarithm	1 (Q12)	1 (Q13)	1 (Q14)	1 (Q15)	0	1 (Q16)	**5**
Algebraic Fractions	1 (Q17)	1 (Q18)	1 (Q19)	0	0	1 (Q20)	**4**
Total	**5**	**4**	**5**	**2**	**2**	**2**	**20**

09048475869
Timothy Prof Anodaowa's

Mathematics Achievement Test (MAT)

School.....

Gender: Male [ ] Female [ ] Class : SSS 2

Age..... Time allowed: 50 minutes

Instruction: answer all questions by circling the correct option.

1. Make Q the subject of the formula when $L = \frac{4}{3} M\sqrt{PQ}$

   a. $Q = \frac{9L^2}{16M^2 P}$ b. $Q = \frac{3L}{4M\sqrt{P}}$ c. $Q = \frac{\sqrt{3L}}{16M^2 P}$ d. $Q = \frac{3L^2}{16M^2}$ p

2. If $P = \frac{\sqrt{rS^2}}{t}$, express r in term of P, S and t? No key

   a. $P = \frac{P^2 t}{S^3}$ b. $P = \frac{P^3 t}{S^3}$ c. $P = \frac{P^2 t}{S^2}$ d. $P = \frac{Pt}{S^3}$

3. Make Q the subject of the relation $t = \sqrt{(PQ/r - r^2 Q)}$ Ambiguous question

   a. $Q = \frac{rt^2}{(P-r^3)}$ b. $Q = \frac{t^2}{(P-r^2)}$ c. $Q = \frac{rt}{(P-r^3)}$ d. $Q = \frac{P-r^3}{rt^2}$

4. Find the area of a rectangle of length 4cm and whose diagonal is 8cm, (leave your answer in surd form).

   a. $8\sqrt{3cm^2}$ b. $12\sqrt{3cm^2}$ c. $16\sqrt{2cm^2}$ d. $16\sqrt{3cm^2}$

   $16\sqrt{3}\ cm^2$

5. Make Q the subject of the formula if $P = \frac{M}{5}(X + Q) + 1$.

   a. $\frac{5P-MX+5}{M}$ b. $\frac{5P-MX-5}{M}$ c. $\frac{5P+MX+5}{M}$ d. $\frac{5P+MX-5}{M}$

6. Make ***u*** the subject in $x = \frac{2u-3}{3u+2}$

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

   $\frac{2x+3}{2-3x}$ No key

7. A solid brass cube is melted and recast as a cone of height ***h*** and base radius ***r***. If the height of the cube is ***h***, find r in terms of ***h***.

a. r = h b. $r = \frac{\sqrt{3h^2}}{л}$ c. $r = л$ d. $r = h\frac{\sqrt{3}}{h}$

8. Given that $r = \frac{\sqrt{3V}}{лh}$, make V the subject of the formula.

a. $V = 3лr^2h$ b. $V = \frac{лrh}{3}$ c. $V = \frac{лr^2h}{3}$ d. $V = 3лrh$

9. Make ***t*** the subject of $k = m\frac{\sqrt{t-P}}{r}$

a. $\frac{k^2r+p}{m^2}$ b. $\frac{k^2r+pm^2}{m^2}$ c. $\frac{k^2r-p}{m^2}$ d. $\frac{k^2r+p^2}{m^2}$

10. Make x the subject of the formula: $y = \frac{3x-9c}{4x+5d}$

a. $x = \frac{-(9c-5dy)}{4y-3}$ b. $\frac{9c-5dy}{4y-3}$ c. $x = \frac{9c-5dy}{4y-3}$ d. $x = \frac{-(9c-5dy)}{4y-3}$

11. Calculate the percentage error if The mass of a student is 62kg to 2 s.f. (a) 0.91% (b) 0.81% (c) 0.801% (d) 0.701%

12. Find the 6th terms of the sequence whose nth term is (2n + 1) __(a) 12 (b) 11 (c) 13 (d) 15

13. Find the 9th terms of the sequence whose nth term is 3 – 5n. (a) +42 (b) -42 (c) -45 (d) +13

14. A sequence in which the terms either increase or decrease in equal steps is called an___ (a) Set (b) Geometric progression (c) Arithmetic progression (d) Integer

15. Given the A.P, 9, 12, 15, 18 ..... find the 50th term. (a) 156 (b) 158 (c) 157 (d) 137

16. A sequence in which the terms either increase or decrease in a common ratio is called a___(a) Set (b) Geometric progression (c) Arithmetic progression (d) Rational

17. Given the GP 5, 10, 20, 40. Find its 9th term. (a) 1280 (b) 1290 (c) 1291 (d) 1270

18. Find two numbers whose difference is 5 and whose product is 266. (a) X=13,X=-19 (b) X=14,X=+19 (c) X=14,X=-19 (d) X=13,X=+19

19. Solve for x and y in the equations 2x +5y= 1 and 3x – 2y =30 (a) y =-3, x=8 (b) y =+3, x=7 (c) y =-3, x=9 (d) y =+3, x=9

20. Seven cups and eight plates cost N1750, eight cups and seven plates cost N1700. Calculate the cost of a cup and a plate. (a) Each cup cost ₦90 and each plate cost ₦120 (b) Each cup cost ₦90 and each plate cost ₦140 (c) Each cup cost ₦40 and each plate cost ₦144 (d) Each cup cost ₦70 and each plate cost ₦134

Observation/Recommendation

- Avoid typographical errors
- Typeset your questions professionally to avoid ambiguity
- Measure each item has a key.
- Time allowed should not exceed 50 minutes.

Validated by Dr. A-O. Sunday
on 25th February, 2025.

Marking scheme for MAT

1. A 2. A 3. A 4. D 5. B

6. C 7. B 8. C 9. D 10. D

11. B 12. C 13. B 14. C 15. A

16. B 17. A 18. C 19. A 20. B

APPENDIX E

SUMMARY OF RELIABILITY TEST ON MATHEMATICS ACHIEVEMENT TEST

```
SAVE OUTFILE='C:\Users\user\Desktop\AZENDA ENTRY RELIABILITY .sav'
  /COMPRESSED.
      VARIABLES = Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 ('ALL
      VARIABLES') ALL MODEL = ALPHA.
/SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=DESCRIPTIVE SCALE
  /SUMMARY=TOTAL.
```

Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

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

Reliability Statistics

Kuder-Richardson	N of Items
.788	20

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Kuder-Richardson if Item Deleted
Item 1	45.25	66.127	.375	.708
Item 2	45.20	69.723	.159	.845
Item 3	45.15	67.857	.438	.729
Item 4	45.20	62.856	.651	.824
Item 5	45.30	69.084	.230	.830
Item 6	45.40	65.210	.534	.625
Item 7	45.40	63.000	.672	.805
Item 8	45.25	66.143	.505	.817
Item 9	45.20	65.525	.460	.725
Item 10	45.55	67.343	.551	.725
Item 11	45.70	65.242	.684	.827
Item 12	46.15	62.475	.573	.828
Item 13	46.45	62.790	.580	.825
Item 14	46.10	60.803	.556	.830
Item 15	46.10	60.277	.682	.811
Item 16	45.65	63.401	.680	.811
Item 17	46.05	60.160	.722	.826
Item 18	45.55	62.761	.642	.725
Item 19	45.60	63.382	.702	.825
Item 20	46.00	64.640	.588	.826

SUMMARY OF RELIABILITY TEST ON MATHEMATICS INTEREST SCALE

```
SAVE OUTFILE='C:\Users\user\Desktop\AZENDA ENTRY RELIABILITY .sav'
  /COMPRESSED.
/VARIABLES=Item1 Item2 Item3 Item4 Item5 Item6 Item7 Item8 Item9 Item10
Item11 Item12 Item13 Item14 Item15 Item16 Item17 Item18 Item19 Item20
/SCALE('ALL VARIABLES') ALL
/MODEL=ALPHA
/STATISTICS=DESCRIPTIVE SCALE
/SUMMARY=TOTAL.
```

Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

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

Reliability Statistics

Cronbach's Alpha	N of Items
.842	20

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item 1	79.85	54.817	.828	.893
item 2	79.56	56.280	.647	.886
Item 3	80.23	63.750	.474	.768
item 4	81.00	54.643	-.352	.913
Item 5	79.75	55.847	.516	.766
Item 6	81.35	56.780	.260	.830
Item 7	79.29	55.487	.277	.907
Item 8	80.76	44.283	-.182	.783
Item 9	79.30	45.280	.255	.820
Item 10	80.74	38.783	.471	.745
Item 11	79.68	38.250	.385	.818
Item 12	79.32	39.360	.486	.924
Item 13	81.33	45.280	.271	.857
Item 14	80.59	38.837	.385	.828
Item 15	79.50	37.583	.535	.784
Item 16	81.22	37.877	.420	.827
Item 17	79.26	39.183	.488	.919
Item 18	80.77	38.880	.270	.827
Item 19	81.25	37.853	.369	.953
Item 20	79.45	38.227	-.463	.788

APPENDIX F

TRAINING MANUAL FOR RESEARCH ASSISTANT

VIRTUAL TECHNOLOGY TEACHING STRATEGY IN TEACHING MATHEMATICS

Introduction

Welcome to the Virtual Technology Teaching Strategy Training Manual. This manual is designed to equip you with the knowledge and skills to effectively use virtual technology in teaching Mathematics to Senior Secondary School students. By the end of this training, you will be able to plan, deliver, and evaluate engaging online Mathematics lessons that improve student achievement and promote equitable learning.

Objectives

By completing this training, participants will be able to:

- Understand the principles of virtual technology teaching.
- Identify and use appropriate digital tools and platforms.
- Design effective, student-centred virtual Mathematics lessons.
- Facilitate interactive and engaging online learning experiences.
- Assess students' understanding and progress in a virtual environment.
- Address common challenges in virtual teaching.

Training Outline

1. Overview of Virtual Technology Teaching Strategy

Definition:

Virtual Technology Teaching Strategy involves using online tools, platforms, and resources to deliver instruction, facilitate interaction, and assess learning remotely or in blended contexts.

Key Features:

- Use of computers, tablets, smartphones.
- Learning Management Systems (LMS) like Google Classroom, Moodle.

- Video conferencing (Zoom, Microsoft Teams).
- Interactive whiteboards and digital resources.
- Recorded lessons and simulations.

Benefits:

- Flexible learning.
- Access to diverse resources.
- Improved engagement with multimedia.
- Equitable opportunities for all students.

2. Preparing for Virtual Teaching

- **Understand Your Students:** Survey access to devices, internet reliability.
- **Set up the Learning Space:** Ensure quiet, well-lit environment.
- **Familiarize with Tools:** Practice using chosen platforms.
- **Set Expectations:** Communicate rules and goals clearly to students.

Checklist:

1. Internet connection tested
2. Device ready (computer, tablet, smartphone)
3. Headphones and microphone
4. Teaching materials prepared

3. Tools and Platforms

Recommended Tools:

- Video conferencing: Zoom, Google Meet.
- LMS: Google Classroom, Edmodo.
- Digital whiteboard: Jamboard, Microsoft Whiteboard.
- Screen recording: Loom.
- Mathematics-specific resources: GeoGebra, Desmos.

Training Activity:

- Practice joining and hosting a Zoom session.
- Create a Google Classroom and upload an assignment.

4. Lesson Planning and Design

Steps:

1. Identify clear learning objectives.
2. Choose engaging activities (videos, quizzes, discussions).
3. Plan for interaction (polls, breakout rooms).
4. Prepare visual aids (slides, whiteboard).
5. Include time for questions and practice.

Example Plan:

- **Objective:** Solve quadratic equations.
- **Activity:** Short video explanation, live demonstration on whiteboard, student practice in breakout groups.
- **Assessment:** Online quiz via Google Forms.

5. Delivering Virtual Mathematics Lessons

- **Start with Warm-up:** Short, engaging question or poll.
- **Present Clearly:** Use slides, share screen, explain concepts step-by-step.
- **Demonstrate:** Work through examples live.
- **Encourage Participation:** Ask questions, invite students to share answers.
- **Check for Understanding:** Use quick quizzes or polls.
- **Summarise:** Review key points.

6. Engaging Students Online

- Use interactive tools (polls, whiteboards).
- Call on students by name.

- Set collaborative tasks in breakout rooms.
- Incorporate multimedia (videos, simulations).
- Provide positive feedback.
- Encourage peer-to-peer discussion.

7. Assessment Strategies

- Online quizzes (Google Forms, Kahoot!).
- Oral questioning during live sessions.
- Assignments uploaded via LMS.
- Peer assessments.
- Self-assessments and reflections.
- Regular feedback and grading.

8. Managing Challenges

Connectivity Issues:

- Share recorded lessons for later access.
- Use low-data tools when possible.

Student Distraction:

- Keep sessions short and engaging.
- Use interactive activities.
- Set clear expectations and rules.

Technical Difficulties:

- Practice using tools in advance.
- Have a backup plan (phone call, alternative platform).

Equity Concerns:

- Plan for device sharing.
- Provide printed resources if needed.

- Advocate for school support to improve access.

9. Practical Sessions and Activities

- Host a mock virtual lesson with peers.
- Practice using interactive whiteboards.
- Create and share an online quiz.
- Record and review a teaching video.
- Simulate student breakout room activities.

10. Monitoring and Reflection

- Reflect after each lesson: What worked? What didn't?
- Gather student feedback.
- Adjust strategies to improve engagement and understanding.
- Share experiences with colleagues.
- Keep learning new tools and methods.

11. Appendices and Resources

Sample Lesson Plan Template

- Objective:
- Materials:
- Introduction:
- Main Activity:
- Practice/Interaction:
- Assessment:
- Closing/Summary:

Links to Free Tools:

- Google Classroom: https://classroom.google.com
- Zoom: https://zoom.us

- Kahoot!: https://kahoot.com
- GeoGebra: https://www.geogebra.org
- Desmos: https://www.desmos.com
- Loom (screen recording): https://www.loom.com

Conclusion

This manual is designed to help you confidently implement virtual technology teaching strategies in your Mathematics classroom. By embracing these tools and practices, you can create inclusive, engaging, and effective learning experiences that improve students' achievement and interest in Mathematics.

APPENDIX G

LESSON PLANS FOR EXPERIMENTAL GROUP

LESSON PLAN 1 **METHOD: VIRTUAL TECHNOLOGY**
TEACHING STRATEGY

CHANGE OF SUBJECT OF FORMULA AND SUBSTITUTION INTO FORMULA

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	**Topic/ Sub-Topic**	**Objectives**	**Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities**	**Items**	**Evaluation/ Exercise Remarks**
Monday/ 9th of Dec. 2024/ 40 MINS	**TOPIC:** Change of subject of formula and substitution into formula **SUB-TOPIC:** Formula and substitution into formula	At the end of the lesson, students should be able to: Define a formula and explain the meaning of subject of formula. Give examples of formula Find the value of the subject given the values of other variables.	Keywords/Vocabulary List: Change, Subject, Formula INTRODUCTION ( ): Teacher revises the concept of equations A formula is simply an equation which describes the relationship between two or more quantities. For example, the formula for finding the area of a trapezium is, $A = \frac{1}{2}(a+b)h$, where a and b are the parallel sides and h is the perpendicular distance between the parallel sides. Since A is expressed in terms of other quantities a, b and h, the quantity A in this case is called the subject of formula. The value of A can be evaluated by substituting the values of a, b and h in the formula. For example if a=2cm, b=3cm and h=6cm, then $A = \frac{1}{2}(2+3)6$ A = 15cm^2 ***Students' Activities:*** Students copy the examples **ACTIVITIES:** Step 2 ( ) More examples of formula are: Newton's law of universal gravitation is given by the formula $F = \frac{Gm_1m_2}{r^2}$, G is a universal constant of	-Generator -Laptop/ Computer -Google Jamboard software	If b= $\frac{a}{a-5} + \frac{a}{a+7}$, find b when a = -4

			gravitation, m_1, m_2 are the masses of objects and r is the distance between the centres of these balls. The formula for finding the period of oscillation of simple pendulum is given by $T = 2\sqrt{\frac{l}{g}}$, where l is the length of a pendulum and g is the acceleration due to gravity. ***Students' Activities:*** Students copy the examples Step 3 ( ) The sum of squares of the first n integers is given by $S_n = \frac{n(n+1)(2n+1)}{6}$ a. Calculate S_{20} b. The sum of the squares from 21 to 40 inclusive. Solution: a. $S_{20} = \frac{20(20+1)(2*20+1)}{6}$ $S_{20} = 2870$ b. The sum of squares from 21 to 40 inclusive = sum of squares from I to 40 minus sum of squares from 1 to 20. Sum of squares from 21 to 40 = $S_{40} - S_{20}$ =22140 – 2870 =19270 ***Students' Activities:*** Students copy the solution. CONCLUSION ( ): Teacher concludes by stating the main point of the lesson.		

LESSON PLAN 2 **METHOD: VIRTUAL TECHNOLOGY**
TEACHING STRATEGY

ALGEBRAIC FRACTIONS

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	**Topic/ Sub-Topic**	**Objectives**	**Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities**	**Items**	**Evaluation/ Exercise Remarks**
Wednesday/ 10th of Dec. 2024/ 40 MINS	**TOPIC:** Algebra **SUB-TOPIC:** Algebraic Fractions	At the end of the lesson, students should be able to: Define algebraic fractions and differentiate them from numerical fractions Simplify algebraic fractions by factorization and cancellation Add and subtract algebraic fractions with like and unlike denominators Multiply and divide algebraic fractions Solve equations involving algebraic fractions	Keywords/Vocabulary List: Algebra, Numerical Fraction INTRODUCTION: Step 1: Teacher Begins with Begin by reviewing numerical fractions with simple examples: E.g., $\frac{2}{3}+\frac{1}{3}$ Ask students what would change if the numerators or denominators had algebraic expressions. Present a sample algebraic fraction: $\frac{x^2+3x}{x}$ ***Students' Activities:*** Students identify the similarity to normal fractions but with algebraic expressions **ACTIVITIES:** Step 2: Simplify: $\frac{x^2+3x}{x}$ $=\frac{x(x+3)}{x}$ = x + 3 Step 3: Add the following: i. $\frac{2x}{x+1}+\frac{3x}{x+1}$ ii. $\frac{1}{x}+\frac{1}{x+2}$ i. $\frac{2x}{x+1}+\frac{3x}{x+1}$	- Generator -Laptop/ Computer -Google Jamboard software	Simplify the following and submit online: i. $\frac{x^2-4x}{x}$ ii. $\frac{x^2-4}{x+2}$ x $\frac{x+2}{x-2}$ iii. $\frac{x^2-9}{x^2-x-6}$ iv. $\frac{3}{x}+\frac{2}{x+1}$

			$= \frac{2x+3x}{x+1}$ $= \frac{5x}{x+1}$ ii. $\frac{1}{x} + \frac{1}{x+2}$ $= \frac{x+2+x}{x(x+2)}$ $= \frac{2x+2}{x(x+2)}$ $= \frac{2(x+1)}{x(x+2)}$ Step 4: Simplify $\frac{2x}{x^2-9}$ x $\frac{x+3}{4x}$ $= \frac{2x(x+3)}{(x+3)(x-3)4x}$ $= \frac{1}{2(x-3)}$ Simplify $\frac{x^2-1}{x^2+x} \div \frac{x-1}{x}$ $= \frac{(x-1)(x+1)}{x(x+1)}$ x $\frac{x}{x-1}$ $= \frac{x(x+1)}{x(x+1)}$ = 1 Step 5: Solve the equation $\frac{1}{x} + \frac{2}{x+1} = \frac{3x+1}{x(x+1)}$ $\frac{x+1+2x}{x(x+1)} = \frac{3x+1}{x(x+1)}$ $(3x + 1)(x^2 + x) = (3x + 1)(x^2 + x)$ $3x^3 + 4x^2 + x = 3x^3 + 4x^2 + x$ $= 3x^3 + 4x^2 + x - (3x^3 + 4x^2 + x)$ = 0 ***Students' Activities:*** Students patiently look at the steps		

			involved in simplification and solving of Algebraic Fraction **Conclusion:** Teacher Reiterates the importance of simplifying algebraic fractions. Stresses the use of LCM in addition/subtraction and factorization in all operations.		

LESSON PLAN 3 **METHOD: VIRTUAL TECHNOLOGY**
TEACHING STRATEGY

QUADRATIC EQUATION

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	**Topic/ Sub-Topic**	**Objectives**	**Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities**	**Items**	**Evaluation/ Exercise Remarks**
Wednesday/ 11th of Dec. 2024/ 40 MINS	**TOPIC:** Quadratic Equation **SUB-TOPIC:** Solving Quadratic Equations using Different Methods	At the end of the lesson, students should be able to: Identify the standard form of a quadratic equation. Solve quadratic equations using: Factorization Completing the square Apply knowledge of quadratic equations to solve word problems.	Keywords/Vocabulary List: Quadratic Equation, Factorization, Standard Form INTRODUCTION: Step 1: Teacher Begins with a real-life scenario: e.g., calculating the area of a garden with quadratic dimensions. Quadratic equations are foundational to higher algebra, physics, economics, and engineering. Understanding different solving techniques prepares students for real-life problem-solving and future academic pursuits. Example of quadratic equation quadratic equation: $x^2 + 5x + 6 = 0$ Quadratic equations are polynomials of degree 2 with the standard form $ax^2 + bx + c = 0$ where $a \neq 0$ ***Students' Activities:*** Students listen and use google to search more on Quadratic Equation **ACTIVITIES:**	-Generator -Laptop/ Computer -Google Jamboard software	Solve the quadratic equation $x^2 - 7x + 10 = 0$ using factorization and completing the square method. Submit you work online

			Step 2: Solving by Factorization $x^2+5x+6=0$ $x^2 + 2x + 3x +6 = 0$ Factor: $(x+2)(x+3) = 0$ $x = -2$ or $x = -3$ Solving by Completing the Square $x^2 + 6x + 5 = 0$ Rearrange and complete the square: $x^2 + 6x = -5$ $x^2 + 6x + 9 = 4$ $x + 3 = \pm 2$ $x = -1$ or -5 Step 3: A rectangular area has a length of x and width x+3 and area is 40 cm^2. Find the value of x. Equation: $x(x+3) = 40$ $x^2 + 3x - 40 = 0$ $x^2 + 8x – 5x – 40 = 0$ $x(x + 8) – 5(x + 8) = 0$ $(x – 5)(x + 8) = 0$ X = 5 or -8 ***Students' Activities:*** Students copy the examples CONCLUSION: Teacher concludes by stating the main point of the lesson.		

LESSON PLANS FOR CONTROL GROUP

LESSON PLAN 1 **METHOD: CONVENTIONAL**

CHANGE OF SUBJECT OF FORMULA AND SUBSTITUTION INTO FORMULA

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	Topic/ Sub-Topic	Objectives	Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities	Items	Evaluation/ Exercise Remarks
Monday/ 9th of Dec. 2024/ 40 MINS	**TOPIC:** Change of subject of formula and substitution into formula **SUB-TOPIC:** Formula and substitution into formula	At the end of the lesson, students should be able to: Define a formula and explain the meaning of subject of formula. Give examples of formula Find the value of the subject given the values of other variables.	Keywords/Vocabulary List: Change, Subject, Formula INTRODUCTION ( ): Teacher revises the concept of equations A formula is simply an equation which describes the relationship between two or more quantities. For example, the formula for finding the area of a trapezium is, $A = \frac{1}{2}(a+b)h$, where a and b are the parallel sides and h is the perpendicular distance between the parallel sides. Since A is expressed in terms of other quantities a, b and h, the quantity A in this case is called the subject of formula. The value of A can be evaluated by substituting the values of a, b and h in the formula. For example if a=2cm, b=3cm and h=6cm, then $A = \frac{1}{2}(2+3)6$ A = 15cm^2 ***Students' Activities:*** Students copy the examples **ACTIVITIES:** Step 2 ( ) More examples of formula are: Newton's law of universal gravitation is given by the formula $F = \frac{Gm_1m_2}{r^2}$, G is a universal constant of gravitation, m_1, m_2 are the masses of objects and r is the distance between the centres of these balls.	Notebooks, sets of formulas.	If b= $\frac{a}{a-5} + \frac{a}{a+7}$, find b when a = -4

			The formula for finding the period of oscillation of simple pendulum is given by $T = 2\sqrt{\frac{l}{g}}$, where l is the length of a pendulum and g is the acceleration due to gravity. ***Students' Activities:*** Students copy the examples Step 3 ( ) The sum of squares of the first n integers is given by $S_n = \frac{n(n+1)(2n+1)}{6}$ c. Calculate S_{20} d. The sum of the squares from 21 to 40 inclusive. Solution: c. $S_{20} = \frac{20(20+1)(2*20+1)}{6}$ $S_{20} = 2870$ d. The sum of squares from 21 to 40 inclusive = sum of squares from I to 40 minus sum of squares from 1 to 20. Sum of squares from 21 to 40 = $S_{40} - S_{20}$ =22140 – 2870 =19270 ***Students' Activities:*** Students copy the solution. **Conclusion:** Teacher concludes by stating the main point of the lesson.		

LESSON PLAN 2 **METHOD: CONVENTIONAL**

ALGEBRAIC FRACTIONS

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	**Topic/ Sub-Topic**	**Objectives**	**Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities**	**Items**	**Evaluation/ Exercise Remarks**
Wednesday/ 10th of Dec. 2024/ 40 MINS	**TOPIC:** Algebra **SUB-TOPIC:** Algebraic Fractions	At the end of the lesson, students should be able to: Define algebraic fractions and differentiate them from numerical fractions Simplify algebraic fractions by factorization and cancellation Add and subtract algebraic fractions with like and unlike denominators Multiply and divide algebraic fractions Solve equations involving algebraic fractions	Keywords/Vocabulary List: Algebra, Numerical Fraction INTRODUCTION: Step 1: Teacher Begins with Begin by reviewing numerical fractions with simple examples: E.g., $\frac{2}{3}+\frac{1}{3}$ Ask students what would change if the numerators or denominators had algebraic expressions. Present a sample algebraic fraction: $\frac{x^2+3x}{x}$ ***Students' Activities:*** Students identify the similarity to normal fractions but with algebraic expressions **ACTIVITIES:** Step 2: Simplify: $\frac{x^2+3x}{x}$ $=\frac{x(x+3)}{x}$ = x + 3 Step 3: Add the following: i. $\frac{2x}{x+1}+\frac{3x}{x+1}$ ii. $\frac{1}{x}+\frac{1}{x+2}$ i. $\frac{2x}{x+1}+\frac{3x}{x+1}$	Notebooks, Textbooks and whiteboard	Simplify the following: i. $\frac{x^2-4x}{x}$ ii. $\frac{x^2-4}{x+2}$ x $\frac{x+2}{x-2}$ iii. $\frac{x^2-9}{x^2-x-6}$ iv. $\frac{3}{x}+\frac{2}{x+1}$

			$=\frac{2x+3x}{x+1}$ $=\frac{5x}{x+1}$ ii. $\frac{1}{x}+\frac{1}{x+2}$ $=\frac{x+2+x}{x(x+2)}$ $=\frac{2x+2}{x(x+2)}$ $=\frac{2(x+1)}{x(x+2)}$ Step 4: Simplify $\frac{2x}{x^2-9}$ x $\frac{x+3}{4x}$ $=\frac{2x(x+3)}{(x+3)(x-3)4x}$ $=\frac{1}{2(x-3)}$ Simplify $\frac{x^2-1}{x^2+x}\div\frac{x-1}{x}$ $=\frac{(x-1)(x+1)}{x(x+1)}$ x $\frac{x}{x-1}$ $=\frac{x(x+1)}{x(x+1)}$ = 1 Step 5: Solve the equation $\frac{1}{x}+\frac{2}{x+1}=\frac{3x+1}{x(x+1)}$ $\frac{x+1+2x}{x(x+1)}=\frac{3x+1}{x(x+1)}$ $(3x + 1)(x^2 + x) = (3x +1)(x^2 + x)$ $3x^3 + 4x^2 + x = 3x^3 + 4x^2 + x$ $= 3x^3 + 4x^2 + x – (3x^3 + 4x^2 + x)$ = 0 ***Students' Activities:*** Students patiently look at the steps		

			involved in simplification and solving of Algebraic Fraction **Conclusion:** Teacher Reiterates the importance of simplifying algebraic fractions. Stresses the use of LCM in addition/subtraction and factorization in all operations.		

LESSON PLAN 3 **METHOD: CONVENTIONAL**

QUADRATIC EQUATION

SUBJECT: Mathematics **REFERENCE:** M.F. Macrae et al. (2016). New General Mathematics for SS2

CLASS: SS 2

Day / Date / Duration	**Topic/ Sub-Topic**	**Objectives**	**Teaching/Learning Materials Keywords/Vocabulary List Teacher/Learner Activities**	**Items**	**Evaluation/ Exercise Remarks**
Wednesday/ 11th of Dec. 2024/ 40 MINS	**TOPIC:** Quadratic Equation **SUB-TOPIC:** Solving Quadratic Equations using Different Methods	At the end of the lesson, students should be able to: Identify the standard form of a quadratic equation. Solve quadratic equations using: Factorization Completing the square Apply knowledge of quadratic equations to solve word problems.	Keywords/Vocabulary List: Quadratic Equation, Factorization, Standard Form INTRODUCTION: Step 1: Teacher Begins with a real-life scenario: e.g., calculating the area of a garden with quadratic dimensions. Quadratic equations are foundational to higher algebra, physics, economics, and engineering. Understanding different solving techniques prepares students for real-life problem-solving and future academic pursuits. Example of quadratic equation quadratic equation: $x^2 + 5x + 6 = 0$ Quadratic equations are polynomials of degree 2 with the standard form $ax^2 + bx + c = 0$ where $a \neq 0$ ***Students' Activities:*** Students listen and use google to search more on Quadratic Equation	Notebooks, Textbooks and whiteboard	Solve the quadratic equation $x^2 - 7x + 10 = 0$ using factorization and completing the square method.

			ACTIVITIES: Step 2: Solving by Factorization $x^2+5x+6=0$ $x^2 + 2x + 3x +6 = 0$ Factor: $(x+2)(x+3) = 0$ $x = -2$ or $x = -3$ Solving by Completing the Square $x^2 + 6x + 5 = 0$ Rearrange and complete the square: $x^2 + 6x = -5$ $x^2 + 6x + 9 = 4$ $x + 3 = \pm 2$ $x = -1$ or -5 Step 3: A rectangular area has a length of x and width x+3 and area is 40 cm². Find the value of x. Equation: $x(x+3) = 40$ $x^2 + 3x - 40 = 0$ $x^2 + 8x – 5x – 40 = 0$ $x(x + 8) – 5(x + 8) = 0$ $(x – 5)(x + 8) = 0$ $X = 5$ or -8 ***Students' Activities:*** Students copy the examples **Conclusion:** Teacher concludes by stating the main point of the lesson.		

APPENDIX H

STUDENTS' ENROLMENT

FCT SECONDARY EDUCATION BOARD
DIRECTOR/SEC. OFFICE
26 AUG 2024
RECEIVED
Sign.....

Azenda Timothy Ikyulavwase,
Post Graduate Student,
Science and Environmental Education Dept.
Faculty of Education,
University of Abuja.
26th August, 2024.

The Director/Secretary,
FCT Secondary Education Board,
Area 3, Garki,
Abuja.

Dear Sir,

REQUEST FOR SS II ENROLLMENT DATA

I write to request for enrollment data of SS II Students of Public Senior Secondary Schools in Bwari Area Council FCT, Abuja. This is enable me continue with my research which is currently going on at University of Abuja.

I am a post graduate student with **Registration No.: 19/404SEEU/007** of Department of Science and Environmental Education of the above mentioned University.

Attached is my letter of introduction from the Department.

Thank you for your kindness.

Yours faithfully,

26/8/2024
Azenda Timothy Ikyulavwase
09048475669

2022/2023 Academic Session

S/N		SCHOOLS	SS2			
			ST	M	F	T
		ABAJI AC				
1	1	ABAJI GDSS	3	100	132	**232**
2	2	ABAJI GGSS	5	0	580	**580**
3	3	AGYANA GSS	3	40	41	**81**
4	4	ALU GSS		18	19	**37**
5	5	GAWU GSS	5	164	146	**310**
6	6	MAWOGI-GAWU GSS	2	14	3	**17**
7	7	NAHARATI GSS	3	91	69	**160**
8	8	NUKU GSS	2	21	26	**47**
9	9	PANDAGI GSS	3	92	83	**175**
10	10	YABA GSS	4	110	90	**200**
			30	**650**	**1189**	**1839**
		BWARI AC				
11	1	BWARI GDSS	12	596	480	**1076**
12	2	BWARI GSS	11	550	510	**1060**
13	3	BYAZHIN GSS	8	272	490	**762**
14	4	DEIDEI GSS	5	162	189	**351**
15	5	DUTSE GDSS	13	421	541	**962**
16	6	DUTSE GGSS	9	0	874	**874**
17	7	JIBI GSS	6	225	161	**386**
18	8	KAWU GSS	3	45	28	**73**
19	9	KUBWA GSS	13	385	521	**906**
20	10	KUBWA-PH3 GSS	5	117	200	**317**
21	11	MPAPE GSS	5	223	216	**439**
22	12	SHERE GSS	5	129	119	**248**
23	13	USHAFA GSS	4	136	176	312
			99		4505	7766

EDUCATION BOARD

APPENDIX I

Students' Performance in Senior Secondary School Certificate Examination in Mathematics between 2017 and 2024

Year	Total entry	Total obtained credit & above (A1-C6)	% obtained credit & above (A1-C6)	Total obtained (D7-F9)	% obtained (D7-F9)
2017	1,544,234	597,310	38.68	946,924	61.32
2018	1,559,162	666,074	42.72	893088	57.28
2019	1,572,196	785,883	49.98	786,513	50.02
2020	1,590,173	1,020,519	64.18	669,654	35.82
2021	1,538,445	1,003,668	65.24	569,654	34.76
2022	1,560,261	1,274,733	81.70	285,528	18.30
2023	1,613,733	1,287,920	79.81	325,813	21.2
2024	1,814,736	1,301,941	72.12	512,795	27.9

Source: *Test Development Division, West African Examination Council (WAEC) Lagos, Nigeria*

APPENDIX J

RESULTS OUTPUT OF THE SPSS

Mann-Whitney Test

Ranks

Pretest	Teaching Method	N	Mean Rank	Sum of Ranks
INTEREST	Experimental	70	44.57	2044.500
	Control	50	38.92	1836.500
	Total	120		

Ranks

Posttest	Teaching Method	N	Mean Rank	Sum of Ranks
INTEREST	Experimental	70	64.85	2517.500
	Control	50	39.77	1754.500
	Total	120		

Descriptive Statistics

Dependent Variable: Pretest Scores

Teaching Method	Mean	Std. Deviation	N
Experimental	31.55	4.842	70
Control	30.89	4.795	50
Total	31.85	4.287	120

Dependent Variable: Posttest Scores

Teaching Method	Mean	Std. Deviation	N
Experimental	55.94	6.716	70
Control	38.92	5.098	50
Total	54.79	6.163	120

Ranks

	Gender	N	Mean Rank	Sum of Ranks
INTEREST	Male	44	27.97	656.00
	Female	26	25.88	599.00
	Total	70		

Descriptive

	Gender	N	Mean	Std. Deviation	Std. Error Mean
SCORES	Male	44	48.27	8.53	.83579
	Female	26	47.61	7.72	1.03999
	Total	70			

Test Statistics[a]

	INTEREST
Mann-Whitney U	685.000
Wilcoxon W	2428.000
Z	-2.145
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.109[b]

a. Grouping Variable: Teaching Methods

b. Not corrected for ties.

Analysis of Covariance

Between-Subjects Factors

		Value Label	N
GROUP	1.00	Experimental	70
	2.00	Control	50

Descriptive Statistics

Dependent Variable: MATH_SCORES222

GROUP	Mean	Std. Deviation	N
Experimental	41.7000	4.83451	70
Control	33.7200	6.12136	50
Total	38.3750	6.67752	120

Levene's Test of Equality of Error Variances[a]

Dependent Variable: MATH_SCORES22

F	df1	df2	Sig.
1.333	1	118	.251

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.[a]

a. Design: Intercept + Pretest+ GROUP

Tests of Between-Subjects Effects

Dependent Variable: Pretest Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4214.443[a]	2	2107.222	225.840	.000	.794
Intercept	686.568	1	686.568	73.582	.000	.386
Pretest	2357.098	1	2357.098	252.620	.000	.683
GROUP	30.163	1	30.163	3.233	.002	.027
Error	1091.682	117	9.331			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .794 (Adjusted R Squared = .791)

Test Statistics[a]

	INTEREST
Mann-Whitney U	325.000
Wilcoxon W	738.000
Z	-1.216
Asymp. Sig. (2-tailed)	.494
Exact Sig. [2*(1-tailed Sig.)]	.186[b]

a. Grouping Variable: Gender

Tests of Between-Subjects Effects

Dependent Variable: Posttest Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4200.685[a]	2	2100.342	222.301	.000	.792
Intercept	725.230	1	725.230	76.758	.000	.396
Posttest	2909.474	1	2909.474	307.939	.000	.725
GENDER	16.404	1	16.404	1.736	.190	.015
Error	1105.440	117	9.448			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .794 (Adjusted R Squared = .791)