

**Effect of Computer Assisted Instruction on Academic Achievement of Senior Secondary School Students in Geometry in Oluyole Local Government Area, Oyo State**

**Ameen MUHAMMED-RAJI  
LCU/PG/003976**

**Being a MSc (Ed) Thesis Submitted to the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State, Nigeria**

**In Partial Fulfilment for the Requirements of Award of Master of Science Education Degree (MSc (Ed)) in Mathematics Education**

2024

### **Certification**

This is to certify that Ameen Olawale MUHAMMED-RAJI with matriculation number LCU/PG/003976 carried out this research work titled “Effect of Computer Assisted Instruction on Academic Achievement of Senior Secondary School Students in Geometry in Oluyole Local Government Area Oyo State” in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State, Nigeria for the award of Master in Science Education Degree MSc (Ed) in Mathematics Education and that this has not been previously submitted for any degree or certificate in any institution.

.....  
**Dr A. A. Waheed**  
**Supervisor**

.....  
**Date**

.....  
**Prof. Philius Yara**  
**Head of the Department**

.....  
**Date**

## **Dedication**

I dedicate this work to the Almighty God.

Lead City University Ibadan DO NOT COPY

## **Acknowledgments**

The Researcher wishes to express profound gratitude to Lead City University, Ibadan for the opportunity given for undergoing this master's degree.

Firstly, the Researcher acknowledges the guidance and encouragement received from the supervisor, Asso. Prof. A.A Waheed, the Head of Department of Science Education, Prof. P. O. Yara, the Dean of Faculty of Education, Prof. D. A. Odeleye, the Provost of the Post Graduate College, Prof. A.O,Oredein,the Internal/External Examiner,Prof. B. Adebo Prof. S. Ileuma, Prof. O.S Pitan., Asso. Prof. V.E. Akuche, Asso. Prof. T.Oyedeki, Asso. Prof. M.D. Oyetade. I must also appreciate the scholarly contribution of Dr C.O Sam-Kayode who doubled as the Post Graduate coordinator of department of Science Education, Dr. M.M. Ayantunji, Dr. B.S. Omoyajowo, Dr. O.T.P.Killian , Dr. S.N Obi, Dr. D.O. Ayeni, Dr. S David, Dr.O. Gambo, Dr. H. Abdulsemihi, Dr. Y. Ibikunle, Dr. J. Kolashi, Miss O.G. Oduali, Miss A. Awoniyi, and the departmental administrator, Mrs E. Adams who really tutored me well during the course of this programme.

The researcher acknowledges the Commissioner of Education in Oyo State through Zonal Inspector of Education (zone 2) via Oluyole Local Government Local Inspector of Education- Mrs D.B. Adeola for providing relevant information for this research work and for allowing the Researcher to use some of their schools for research field. The support the Researcher received from the selected public schools is worthy to be acknowledged. The Researcher also appreciates all the authors whose works have been cited in this work. This acknowledgment will not be complete without appreciating the research assistance- Mallam S. Sharafadeen and Dr R. Ajadi for their encouragement, dedication and commitment just to

see the research work through. This means a lot. Also, the Researcher recognises the contribution of dear brother and mentor- Alh M. Muhammed-Raji for his support morally and financially. The Researcher specifically appreciate parents, Sheikh K. Muhammed-Raji, and Alhaja H. Muhammed-Raji; dear wives, Mrs A.O. Muhammed-Raji and Mrs A. H. Muhammed-Raji; children – Khaerat, Mubarak, Mukhtar, Mukhlis and Khalida and all other members of family for their sacrifice, support and for enduring absence of the Researcher from home most time to pursue this programme.

Even though the above -mentioned institution and persons have assisted in the process of the research work, The Researcher alone stands responsible for the errors, if any, found in the work.

### **Abstract**

Senior Secondary School students in Nigeria often face significant challenges in mastering geometric concepts, resulting in poor academic achievement in Mathematics. This study aimed to determine the effects of Computer-Assisted Instruction (CAI) on students' academic achievement in geometry, as well as the moderating roles of students' motivation and attitudes. Given the importance of both instructional methods and student characteristics in educational outcomes, this research sought to provide insights into how CAI, combined with motivational factors, can enhance learning in geometry. A quasi-experimental research design was employed, involving a total of 150 students who were randomly assigned to CAI and control groups, which used traditional teaching methods. The students' academic achievement in geometry was assessed using the Geometric Achievement Test (GAT) ( $KR - 20 = 0.81$ ), while their motivation and attitudes towards learning were measured using self-developed questionnaires. The Student Motivation Questionnaire (SMQ) (Cronbach  $\alpha = 0.73$ ) and the Student Attitude Questionnaire (SAQ) (Cronbach  $\alpha = 0.76$ ). Data analysis, using ANCOVA, revealed significant differences in academic achievement between the CAI group and the control group ( $F_{(1,145)} = 54.578$ ,  $p < 0.05$ ), indicating that students exposed to CAI performed significantly better than those taught through conventional methods. Furthermore, the results showed that students' motivation ( $F_{(1,145)} = 5.582$ ,  $p < 0.05$ ) and attitudes ( $F_{(1,145)} = 6.216$ ,  $p < 0.05$ ) had a significant positive effect on their academic achievement in geometry. Additionally, motivation and attitudes were found to moderate the effectiveness of CAI in improving students' performance ( $F_{(1,134)} = 6.353$ ,  $p < 0.05$ ). Based on these findings, the study recommends the integration of CAI into the geometry curriculum, along with targeted teacher training programme to maximise the benefits of technology in education. Furthermore, addressing and fostering positive student motivation and attitudes should be prioritised to further enhance the effectiveness of CAI. This research contributes to the growing body of evidence supporting the potential of CAI in improving learning outcomes in geometry and provides a foundation for future educational interventions.

**Keywords:** Computer-Assisted Instruction, Academic Achievement in Geometry, Students' Motivation

**Word Count:** 300

## Table of Contents

Content	Page
Certification	i
Declaration	ii
Acknowledgement	iii
Abstract	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
List of Acronyms	xii
<b>Chapter One: Introduction</b>	<b>1</b>
1.1 Background to the Study	1
1.2 Statement of the Problem	7
1.3 Aim and Objectives of the Study	8
1.4 Hypotheses	9
1.5 Significance of the Study	10
1.6 Scope of the Study	11
1.7 Limitation of the Study	11
1.8 Operational Definition of Terms	12
Endnotes	13
<b>Chapter Two: Literature Review</b>	<b>15</b>
2.1 Conceptual Review	16
2.1.1 Computer-Assisted Instruction (CAI)	16
2.1.1.1 Advantages CAI	18

2.1.1.2 Disadvantages of CAI	22
2.1.1.3 Types of Computers Assisted Instruction	26
2.1.2 An Overview of Mathematics Education	29
2.1.2 Geometry	32
2.1.2.1 Importance of Geometry	34
2.1.3 Academic Achievement	37
2.1.4 Students' Motivation	39
2.1.5 Students' Attitude	42
<b>2.2 Theoretical Framework</b>	<b>45</b>
2.2.1 Cognitive Load Theory	45
2.2.2 Constructivist Theory	53
<b>2.3 Review of Empirical Studies</b>	<b>63</b>
2.3.1 Traditional Teaching method and Academic Achievement in Geometry	64
2.3.2 Computer Aided Instruction and Academic Achievement in Geometry	69
2.3.3 Students 'Motivation and academic Achievement in Geometry	75
2.3.4 Attitude and Academic Achievement in Geometry	85
2.3.5 Motivation and Attitude to Geometry	90
<b>2.4 Conceptual Model</b>	<b>100</b>
<b>2.5 Summary of Gaps in Literature Reviewed</b>	<b>101</b>
Endnotes	103
<b>Chapter Three: Methodology</b>	<b>112</b>
3.1 Research Design	112
3.2 Population of the study	113

3.3	Sample Size and Sampling Techniques	113
3.4	Description of the Research Instruments	114
3.5	Validity of the Research Instruments	117
3.6	Reliability of the Research Instruments	117
3.7	Method of Data Administration	118
3.8	Method of Data Analysis	118
3.9	Ethical Approval	119
	Endnotes	120
	<b>Chapter Four: Results and Discussion of Findings</b>	<b>121</b>
4.1	Presentation of Data	121
4.2	Answering Hypotheses Questions	125
4.3	Discussion of Findings	131
	Endnotes	140
	<b>Chapter Five: Conclusion</b>	<b>141</b>
5.1	Summary of Findings	141
5.2	Conclusion	142
5.3	Recommendations	142
5.4	Contributions to Knowledge	143
5.5	Suggested Areas for Further Research	144
	Bibliography	145
	Appendix	153
	Bio-data	166
	The University Compliance Certification	170

## List of Tables

<b>Table</b>	<b>Title</b>	<b>Page</b>
3.1	Schemata Representation	112
3.2	Table of Specification for Students Geometry Achievement Test	115
4.1	Demographic Data	121
4.2	Descriptive Statistics of the Dependent Variable – Students Performance in Geometry	122
4.3	Descriptive Statistics of the Independent Variables as measured by Students' Motivation Questionnaire (SMQ) and Students' Attitude Questionnaire (SAQ)	123
4.4	Descriptive Statistics of Students' Performance in Geometry Based on Students Motivation and Students' Attitude	124
4.5	Summary of ANCOVA on the Post Test Achievement Score in Geometry to Teaching Strategies and Motivation and Attitude	125
4.6	Summary of 2-Ways ANCOVA on the Post-test Achievement Scores in Geometry According to Teaching Strategies and Motivation and Attitude	127
4.7	Summary of 3-ways interactions ANCOVA on the Post-test Achievement Scores in Geometry According to Teaching Strategies and Motivation and Attitude	130

## List of Figures

<b>Figure</b>	<b>Title</b>	<b>Page</b>
2.1	CAI Instructor	19
2.2	Circle Geometry Instructor	32
2.3	Conceptual Model	100

Lead City University Ibadan DO NOT COPY

## List of Acronyms

<b>Abbreviation</b>	<b>Meaning</b>
CAI	Computer Assisted/Aided Instruction
TI	Traditional Instruction
CTM	Conventional Teaching Method
WAEC	West African Examination Council
ZPD	Zone of Proximal Development Theory
CMA	Comprehensive Meta-Analysis
CSCI	Computer-Supported Collaborative Learning
ARCS	Attention, Relevance, Confidence, and Satisfaction
BGC	Basic Geometric Concepts
GPS	Geometry Problem-Solving
ICT	Information and Communication Technology
GAT	Geometry Achievement Test
SMQ	Students' Motivation Questionnaire
SAQ	Students' Attitude Questionnaire
ANCOVA	Analysis of Covariance

## Chapter One

### Introduction

#### 1.1 Background to the Study

Mathematics education is fundamental to the intellectual development and future success of individuals, providing essential skills for navigating the complexities of the modern world<sup>1</sup>. Mathematics involves logical reasoning and problem-solving, which are essential for cognitive development. Through mathematical tasks and activities, students learn to analyse situations, identify patterns, and formulate logical solutions<sup>1</sup>. It encourages critical thinking skills by requiring students to evaluate information, make connections between concepts, and apply various strategies to solve problems. This process strengthens analytical skills and fosters a deeper understanding of mathematical concepts<sup>1</sup>. Mathematical concepts often involve abstract ideas and symbolic representation. Engaging with patterns and apply mathematical principles to diverse contexts<sup>1</sup>. It emphasises precision and accuracy in reasoning and communication. Students learn to articulate their abstract mathematical concepts helps develop abstract reasoning skills, enabling students to generalise mathematical thinking clearly and concisely, enhancing their ability to communicate ideas effectively and logically. Mathematics provides opportunities for students to engage in problem-solving activities that require creativity, perseverance, and resilience. By tackling mathematical problems, students develop problem-solving strategies, learn from mistakes, and become more confident in their ability to overcome challenges<sup>2</sup>. Mathematics has countless applications in everyday life, from managing finances and making decisions to understanding

scientific phenomena and analyzing data. By applying mathematical concepts to real-world situations, students develop a deeper appreciation for the relevance and utility of mathematics in their lives<sup>2</sup>. Overall, mathematics serves as a cornerstone for cognitive development and problem-solving skills by fostering logical thinking, critical reasoning, abstract reasoning, precision, and real-world applications. Through mathematics education, students not only acquire mathematical knowledge and skills but also develop essential cognitive abilities that are valuable in various academic, professional, and personal contexts. Despite the fundamental nature of mathematics and its significance in educational curricula, students often encounter challenges comprehending complex topics, particularly in geometry. In Nigeria, Senior Secondary School students face difficulties in mastering geometric concepts, leading to suboptimal academic performance. Traditional teaching methods may not always adequately address these challenges, prompting a need to explore alternative instructional approaches<sup>1,2</sup>.

These challenges include difficulties in visualizing geometric concepts, inadequate engagement with traditional teaching methods, and a lack of personalized learning experiences tailored to individual student needs. The advent of technology in education, particularly Computer-Assisted Instruction (CAI), offers a potential solution to address these challenges<sup>1, 2</sup>. However, the extent to which integrating CAI into the teaching of geometry topics effectively enhances the academic achievement of Senior Secondary School students. Also, the integration of technology, specifically CAI, presents an opportunity to enhance teaching and learning experiences in mathematics<sup>1, 2</sup>. However, the effectiveness of utilizing CAI in improving the academic achievement of

Senior Secondary School students in geometry topics remains under explored within the context of Oluyole Local Government.

The use of computer technology to enhance traditional mathematics teaching and to provide online instruction to secondary school students is a welcome development in Nigeria. Mathematics education is evolving as it explores innovative ways to improve instructional quality for learners. This shift is happening alongside advancements in mathematics education research, which is incorporating new methods and embracing various information technology innovations. While significant research shows that computer-assisted instruction can positively influence learning for students of all ages across various subjects, studies specifically focused on secondary school students remain limited. This is due to factors such as poor comprehension and traditional teaching methods often associated with mathematics. Some researchers suggest that computer-assisted instruction holds great potential for improving education, with technology being viewed as a best practice for teaching mathematics.

The traditional approach to teaching mathematics has long been the primary method used in secondary schools for teaching developmental mathematics<sup>3</sup>. While many researchers acknowledge that computer-assisted instruction (CAI) is innovative, engaging, and helps students learn more quickly, some scholars have found that students taught through both conventional methods and CAI acquire similar knowledge and skills. However, students who learn through CAI tend to develop a more positive attitude towards continuing their study of mathematics. The Traditional Instruction (TI) method involves using conventional tools and techniques to teach mathematics in the classroom, such as rulers, pencils, and paper to cover the subject matter. In this approach, learning

occurs within the classroom, with lessons typically presented on the board, and textbooks are frequently used. The teaching is teacher-centered, with a strong emphasis on the question-and-answer method<sup>4</sup>. In mathematics classes where, traditional teaching methods are predominantly used, students may struggle to fully absorb the extensive material presented by the teacher. With paper-and-pencil methods, students can easily become bored and find it challenging to repeatedly practice problems. Computer-aided instruction (CAI) introduces variety, sparking students' curiosity and allowing them to learn in a more engaging way. Additionally, lessons taught through CAI are more likely to be retained for a longer time since they involve more of the students' senses<sup>3</sup>.

In the current "information age," the rise of technology and computer-based education encourages educators to explore new teaching methods that can be applied in any classroom setting as alternatives to teacher-led techniques. Mathematics instructional programme should incorporate technology to enhance students' understanding of the subject and prepare them to learn mathematics in an increasingly digital world. Computers and the internet enable new ways of delivering instruction, giving students more flexibility in when, where, and how they learn mathematics. Computer-Assisted Instruction (CAI) holds significant potential for enhancing the teaching and learning process at all educational levels. Its use has enriched education by incorporating computers, fostering innovation, creativity, and change in teachers' instructional methods. Both mathematics and computers are essential in modern life, offering vast opportunities. Mathematics is extensively applied in both computer hardware and software. Additionally, computers aid in improving mathematical knowledge and make classroom teaching more engaging and dynamic<sup>3</sup>.

Students' motivation plays a pivotal role in students' academic achievement in geometry, as it does in other subjects<sup>8</sup>. Motivated students are more likely to put in extra effort to understand complex geometric concepts, leading to better grades and academic achievement. Also, Motivation helps students stay focused and engaged during lessons, reducing distractions and allowing them to absorb information more effectively. When faced with challenges, motivated students are more likely to persevere and seek help, leading to a deeper understanding of geometry concepts. Student motivation, in relation to the effect of computer-aided instruction on academic achievement in geometry, refers to the internal and external factors that drive students to engage with and persist in learning geometry using computer-aided instruction. These factors can influence students' enthusiasm, interest, and effort, ultimately affecting their academic achievement in geometry. Students' attitudes towards geometry can significantly impact students' academic achievement in the subject. A positive attitude can boost motivation, leading to increased effort and engagement in learning geometry. Believing in one's ability to learn geometry can enhance confidence, reducing anxiety and increasing persistence. A growth mindset (embracing challenges and learning from failures) helps students overcome obstacles and stay committed to learning. Finding geometry interesting or relevant can increase enjoyment and enthusiasm, leading to deeper understanding and better retention. Students who believe they can master geometry are more likely to take risks, ask questions, and seek help when needed. A positive attitude can foster a stronger, more supportive relationship with teachers, leading to additional guidance and encouragement. However, A negative attitude can lead to increased anxiety and stress, which can impede understanding and performance.

Students' attitudes towards computer-aided instruction (CAI) can significantly impact their academic achievement in geometry. Attitudes can influence students' motivation, engagement, and overall learning outcomes<sup>9</sup>. Positive attitudes: Students enjoy using technology and are excited to learn geometry with CAI. Students feel comfortable using computers and believe CAI can help them understand geometry better. Students see the practical applications of geometry and how CAI can help them in real-life situations. Students are actively involved in the learning process and participate fully in CAI activities. Computer-aided instruction (CAI) in mathematics lessons connects real-world settings with symbolic learning, aligning with students' cognitive development<sup>16</sup>. CAI helps foster the growth of cognitive skills at this stage by offering innovative, concrete resources that support deeper reasoning, explanation, and problem-solving. Additionally, computers play a crucial role in the learning process by stimulating students' imagination. Any mathematical concept can be illustrated using visuals, and these images help students understand concepts more easily.

The interactive features of the software offer an experience where mathematical concepts are presented in nearly tangible forms, making the activities both engaging and challenging. Using computers as a teaching and learning tool provides opportunities for student autonomy, increased motivation, real-world connections, and improved academic performance. This approach enhances student achievement in various ways, including through standardized achievement tests. Likewise, incorporating technology into mathematics instruction is considered a best practice for all students. Technology plays a crucial role in teaching and learning mathematics, as it impacts the subject matter and enhances students' learning experiences. However, it is important to determine how

computer-assisted instruction compares to traditional teaching methods in improving students' performance in mathematics, particularly for students in Nigeria. Therefore, this study aimed to determine the effect of CAI on the academic achievement of Senior Secondary School students in Geometry in Oluyole Local Government.

## **1.2 Statement of the Problem**

It has been observed that students consistently perform poorly on circle theorem questions in the West African Secondary School Certificate Examination. Numerous reports from WAEC Chief Examiners highlighted students' insufficient understanding of circle theorems. This raised several questions: Do teachers introduce circle theorem terminology before teaching the concept? How do teachers approach the teaching of circle theorems? If the concept is taught effectively, why do students continue to struggle with it? If teachers do introduce the relevant terminology and the instruction is effective, what accounts for students' poor performance in this area? Students' performance in circle geometry has suffered due to the use of ineffective instructional strategies during lessons. Chief Examiners have repeatedly noted students' weaknesses and challenges in solving circle theorem problems. Many reports indicate that most candidates tend to avoid answering circle theorem questions, and even among the few who attempt them, there is often a lack of adequate content knowledge. This problem highlighted the need to assess the efficacy of CAI as an intervention tool to mitigate the challenges faced by students in comprehending geometry, and to ascertain whether CAI has the potential to enhance academic achievement in this subject area within the specified educational context. In the

light of this, this study aimed to determine the effects of CAI on academic achievement of Senior Secondary School II Students in Geometry topic in Oluyole Local Government.

### **1.3 Aim and Objectives of the Study**

The aim of the study was to determine the effects of CAI on Academic Achievement of Senior Secondary School Students in Oluyole Local Government, Ibadan, Oyo State, Nigeria. The objectives of the study are to:

- i. examine the main effect of CAI on senior secondary students' academic achievement in geometry;
- ii. determine the main effect of conventional method on senior secondary students' academic achievement in geometry;
- iii. examine the main effect of attitude on senior secondary students' academic achievement in geometry;
- iv. examine the main effect of motivation on senior secondary students' academic achievement in geometry;
- v. determine the interaction effect of CAI and motivation on senior secondary students' academic achievement in geometry;
- vi. determine the interaction effect of CAI and attitudes on senior secondary students' academic achievement in geometry;
- vii. investigate the interaction effect of conventional method and motivation on senior secondary students' academic achievement in geometry;
- viii. examine ascertain the interaction effect of conventional method and attitudes on senior secondary school students' academic achievement in geometry;

- ix. examine the interaction effect of attitude and motivation on senior secondary students' academic achievement in geometry; and
- x. examine the interaction effect of conventional method, motivation and attitude on senior secondary students' academic achievement in geometry.

#### **1.4 Hypotheses**

- H<sub>01</sub>: There will be no significant main effect of CAI on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>02</sub>: There will be no significant main effect of Conventional Method on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>03</sub>: There will be no significant main effect of Motivation on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>04</sub>: There will be no significant main effect of Attitude on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>05</sub>: There will be no significant interaction effect of CAI and Motivation on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>06</sub>: There will be no significant interaction effect of CAI and Attitude on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>07</sub>: There will be no significant interaction effect of Conventional Method and Motivation on Senior Secondary School Students' Academic Achievement in Geometry.
- H<sub>08</sub>: There will be no significant interaction effect of Conventional Method and Attitude on Senior Secondary School Students' Academic Achievement in Geometry.

H<sub>0</sub>9: There will be no significant interaction effect of Motivation and Attitude on Senior Secondary School Students' Academic Achievement in Geometry.

H<sub>0</sub>10: There will be no significant main interaction effect of Conventional Method, Motivation and Attitude on Senior Secondary School Students' Academic Achievement in Geometry.

### **1.5 Significance of the Study**

The effectiveness of Computer-Assisted Instruction helps in enhancing student engagement and interest in learning mathematics, particularly geometry. This has contributed to reducing students' anxiety towards mathematical concepts and improve their overall attitude towards the subject. The study's outcomes highlighted the challenges faced by educators in implementing CAI and suggested areas for professional development. This has led to tailored training programs aimed at improving teachers' technological readiness and pedagogical skills in integrating technology into their teaching practices.

The findings of this study will contribute to enhancing the quality of mathematics by providing insights into the effectiveness of integrating CAI as a supplementary tool. This potentially led to improved learning outcomes in geometry topics among Senior Secondary School students. Understanding the impact of CAI on students' academic achievement in geometry topics has assisted educators and policymakers in adopting more innovative and effective teaching methods. This has paved way for the incorporation of technology-enhanced learning approaches in mathematics education, fostering a more engaging and interactive learning environment.

The study's findings will influence educational policies within Oluyole Local Government by providing empirical evidence on the benefits and challenges of using CAI in mathematics education. This study has added to the existing body of knowledge on technology-enhanced learning and its effect on mathematics education in Oluyole local government. It has provided empirical evidence that could contribute to future research endeavors focusing on educational technology and its implications for student achievement in mathematics.

In summary, the significance of this study lied in its potential to inform educational practices, improve teaching methodologies, enhance student learning experiences, and contribute to the advancement of research in the field of technology-enhanced mathematics education.

### **1.6 Scope of the Study**

The scope of this study was delimited contextually to effect of computer aided instruction on academic achievement of senior secondary school students in geometry and was also delimited geographically to Oluyole Local Government Area, Oyo State.

### **1.7 Limitation of the Study**

The following were the constraints encountered during the course of this study:

- i. Variations in students' access to and familiarity with computer-assisted instruction outside the classroom affected their performance, potentially confounding the study's results.

- ii. Software malfunctions, limited computer availability and internet connectivity problems disrupted the instruction and affected the consistency of the intervention's effect.

## 1.8 Operational Definition of Terms

**Academic Achievement in Geometry:** This is the result of the GAT given to senior secondary school two students of Oluyole Local Government during the study.

**Computer-Assisted Instruction (CAI):** For the purpose of this study, CAI refers to the utilization of computer technology and software applications specifically designed to facilitate and enhance the teaching and learning process of selected geometry topics within mathematics for SSS students in Oluyole Local Government. CAI involves interactive, technology-based educational tools that supplement traditional classroom instruction in geometry.

**Geometry:** For the purpose of this study, these topics will include but are not limited to, angles, polygons, circles, congruence, similarity, and transformations, as identified in the Senior Secondary School curriculum.

**Students 'Attitude to Geometry:** This refers to the students' disposition or mindset towards geometry as a subject. It encompasses their level of interest, enthusiasm, and willingness to engage with geometry lessons. An individual's attitude in this study could be measured through questionnaires assessing students' motivation, enjoyment, and effort in learning geometry, as well as their openness to using CAI tools<sup>9</sup>.

**Student Motivation:** Student motivation, in relation to the effect of CAI on academic achievement in geometry, refers to the internal and external factors that drive students to

engage with and persist in learning geometry using computer-aided instruction. These factors can influence students' enthusiasm, interest, and effort, ultimately affecting their academic achievement in geometry<sup>8</sup>.

Lead City University Ibadan DO NOT COPY

## Endnotes

1. Y. Aiyem, K. Galiya, B. Ademi, M. Adilet, Z. Kamshat, & K. Gulmira, *Development of the Logical Thinking of Future Mathematics Teachers through the use of Digital Educational Technologies*, **Cypriot Journal of Educational Sciences**, 17(6), 2022, 105-109 .
2. J. K. Ansah, F. Quansah, & R. M. Nugba, *Mathematics Achievement in Crisis': Modelling the Influence of Teacher Knowledge and Experience in Senior High Schools in Ghana*, **Open Education Studies Journal**, 2(1), 2020, 265-276.
3. Y. D. Arthur, *Mathematics Teachers' Acceptance of ICT in Teaching and Learning: An Extended Technology Acceptance Model*, **Problems of Education in the 21st Century**, 80(3), 2021, 408-425.
4. S. Bosson-Amedenu, *Pre-SHS Students' Perception of Difficult Concepts in Junior High School Mathematics Curriculum in Ghana*, **Asian Research Journal of Mathematics**, 3(2), 2018 , 1-11 .
5. P. Boyd, & A. Ash, *Mastery Mathematics: Changing Teacher Beliefs around In-Class Grouping and Mindset*, **Teaching and Teacher Education**, 75, 2018, 214-223.
6. C. Constantinou, *Implications of Mathematics Standards on Geometry Education in New York States*, Teachers College, Columbia University Oroquest Dissertation & Theses, 2018, 10828601.
7. J. Carlson, K. R. Daehler, A. C. Alonzo, E. Barendsen, A. Berry, A. Borowski & C. D. Wilson, *The Refined Consensus Model of Pedagogical Content Knowledge in Science Education*, 4(8), 2019, 77-94.
8. P. K. Alheri, U. Burgasa, A. Isah & Y. Gambo, *Motivation and Academic Achievement of Students Toward Sustainable National Development in Nigeria: A Pragmatic Approach*, **African Journal of Humanities and Contemporary Education Research** 6 (1), 2022 , 69-79.
9. P. Mao, Z. Cal, J. He, X. Chen & X. Fan, *The Relationship Between Attitude toward Science and Academic Achievement in Science: A Three -Level Meta-Analysis*, **Frontiers In psychology**, 12, 2021, 784068.
10. S. Cementina, *Language Teachers' Digital Mindsets: Links between Everyday Use and Professional Use of Technology*, **TESL Canada Journal**, 36(3), 2019, 31-54.
11. S. Chand, K. Chaudhary, A. Prasad & V. Chand, *Perceived Causes of Students' Poor Performance in Mathematics: A Case Study at Ba and Tavua Secondary Schools*, **Frontiers in Applied Mathematics and Statistics**, 7, 2021, 75-86.

12. H. Gaspard, E. Wille, S. V. Wormington, & C. S. Hulleman, *How are Upper Secondary School Students' Expectancy-Value Profiles Associated with Performance and University STEM Major? A Cross-Domain Comparison*, **Contemporary Educational Psychology**, 58, 2019, 149-162.
13. W. John & J. D. C. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, New Delhi: SAGE, 2018.
14. R. Kiran, & F. E. Yildiz, *Development of Self-Efficacy for Argumentation Scale*, **Kuramsal Eğitimbilim**, 14(3), 2021, 449-475.3
15. G. Roorda, S. de vries & A. E. Smale- Jacobse, *Using Lesson Study to Help Mathematics Teachers Enhance Students' Problem-Solving Skills with Teaching through Problem Solving*, **Frontiers in Education**, 9, 2024, 1331674.
16. B. Nwoke, *Enhancing Senior Secondary School Students' Performance in Geometry through Origami Instructional Approach*, 2020.
17. C. A. Tabuenal & J. Pentang, *Learning Motivation and Utilization of Virtual Media in Learning mathematics*, **Asia-Africa Journal of Recent Scientific Research**, 1, 2021, 65-75.
18. S. Arik & M. Yilmaz, *The effect of Constructivist Learning Approach and Active Learning on Environmental Education: A Meta Analysis Study*, **International Journal of Science Education and Environmental**, 3(1), 2020.

## **Chapter Two**

### **Literature Review**

#### **2.1 Conceptual Review**

##### 2.1.1 Computer-Assisted Instruction (CAI)

###### 2.1.1.1 Advantages CAI

###### 2.1.1.2 Disadvantages of CAI

###### 2.1.1.3 Types of Computer Assisted Instruction

##### 2.1.2 An Overview of Mathematics Education

##### 2.1.3 Geometry

###### 2.1.3.1 Importance of Geometry

##### 2.1.4 Academic Achievement

##### 2.1.5 Students' Motivation

##### 2.1.6 Students' Attitude

#### **2.2 Theoretical Framework**

##### 2.2.1 Cognitive Load Theory

##### 2.2.2 Constructivist Theory

#### **2.3 Review of Empirical Studies**

##### 2.3.1 Traditional Teaching method and Academic Achievement in Geometry

##### 2.3.2 Computer Aided Instruction and Academic Achievement in Geometry

##### 2.3.3 Students 'Motivation and academic Achievement in Geometry

##### 2.3.4 Attitude and Academic Achievement in Geometry

##### 2.3.5 Motivation and Attitude to Geometry

#### **2.4 Conceptual Model**

## **2.5 Summary of Gaps in Literature Reviewed**

### **2.1 Conceptual Review**

These concepts form the foundational elements of understanding the relationship between utilizing Computer-Assisted Instruction in geometry and its potential effects on the academic performance of secondary school students within the specific context of Oluyole Local Government.

#### **2.1.1 Computer-Assisted Instruction (CAI)**

Computer-Assisted Instruction (CAI) refers to the integration of computers and digital technology into the educational process to support and enhance teaching and learning. It encompasses a broad range of software, applications, and online platforms that facilitate interactive learning experiences, making education more engaging and accessible for students. In the context of mathematics, and specifically geometry, CAI offers a unique opportunity to improve students' understanding and mastery of geometric concepts<sup>1</sup>.

In geometry, CAI involves the use of specialized digital tools such as software programs, apps, or web-based platforms designed to provide interactive exercises, visualizations, simulations, and real-time feedback on students' progress. These technological aids serve to bridge the gap between abstract geometric concepts and the students' ability to understand and apply them effectively. Through CAI, students can engage in dynamic learning activities that allow them to visualize geometric shapes, manipulate angles, and explore geometric principles in a way that would be difficult or impossible in a traditional classroom setting<sup>2,3</sup>.

Interactive exercises within CAI can include virtual manipulatives like geometric shapes that students can rotate, resize, and combine to explore relationships between various geometric figures. Simulations allow students to see the real-time effects of transformations, such as reflections, translations, and rotations, on geometric objects. Additionally, CAI often includes personalized learning experiences, where the system can adapt to each student's pace and skill level, providing individualized instruction that ensures the content is neither too difficult nor too easy for the learner<sup>2</sup>.

One of the key advantages of CAI is its ability to provide immediate feedback. When students engage with CAI-based exercises, they receive instant responses to their inputs, helping them quickly identify errors and understand the correct solutions. This immediate feedback loop enhances students' learning experiences, as they can quickly rectify mistakes and continue progressing at their own pace. Additionally, CAI tools can track students' progress, offering detailed data on their strengths and areas for improvement, which can help instructors tailor their teaching strategies to better meet students' needs<sup>1,2</sup>.

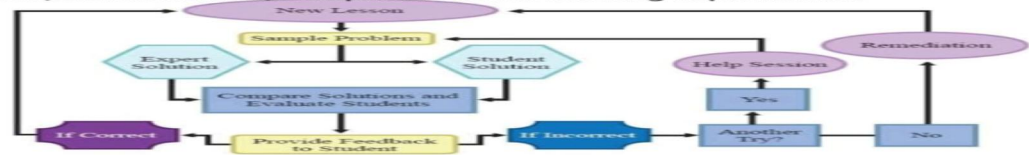
Incorporating CAI into the teaching of geometry allows students to engage more actively in their learning process. By providing opportunities for interactive learning, real-time feedback, and personalized instruction, CAI can enhance students' comprehension, retention, and application of geometric concepts. It also offers a more flexible learning environment, allowing students to revisit difficult topics and practice concepts as needed, fostering independent learning and critical thinking skills. Thus, the integration of CAI in geometry education provides a powerful tool for improving academic performance and understanding of mathematical concepts<sup>3,4</sup>.



...e concepts form the foundational elements of understanding the re...  
...een utilizing Computer-Assisted Instruction in geometry and its potential...  
...ademic performance of secondary school students within the specific...  
...le Local Government.

#### Computer-Assisted Instruction (CAI)

refers to the use of computers and digital technology to aid and en...  
...ning and learning process<sup>1</sup>. In the context of geometry in mathematics, CA...  
...se of software, applications, or online platforms specifically designed...  
...ents in understanding geometric concepts through interactive...  
...lations, visualizations, and personalized learning experiences.



19

Figure 2.1: CAI Instructor<sup>8</sup>

### 2.1.1.1 Advantages of CAI

Computer-Assisted Instruction (CAI) has emerged as a powerful tool in enhancing the learning experience and academic performance of students, particularly in the field of mathematics. Among the various branches of mathematics, geometry stands out as an area where visual representation plays a crucial role in understanding concepts. The integration of CAI into geometry instruction offers numerous benefits that make learning more effective, engaging, and tailored to individual student needs<sup>1,4</sup>.

One of the most significant advantages of CAI in geometry education is its ability to enhance visual learning. Traditional classroom instruction often relies on static diagrams drawn on the board or printed in textbooks, which may not always be sufficient for students to grasp complex geometric concepts. However, with CAI, students have access to dynamic visual aids, graphics, and simulations that bring geometric ideas to life.

These digital tools make abstract concepts more tangible and easier to understand by allowing students to manipulate shapes, observe transformations, and explore geometric relationships in real time. Through interactive animations and three-dimensional models, learners can develop a deeper comprehension of angles, symmetry, congruence, and other fundamental geometric principles<sup>2,3</sup>.

Beyond visualization, CAI promotes interactivity and engagement, which are essential components of effective learning. Unlike passive learning methods where students merely absorb information, CAI encourages active participation by allowing them to explore and interact with geometric concepts. Through interactive software and digital exercises, students can construct geometric figures, measure angles, and test hypotheses, thereby fostering a hands-on approach to learning. This active involvement not only makes the learning process more enjoyable but also improves retention and understanding. By engaging directly with the content, students develop a more intuitive grasp of geometry, making it less intimidating and more accessible<sup>2,4</sup>.

Another crucial benefit of CAI is its capacity for personalized learning. Every student learns at a different pace, and traditional classroom settings often struggle to accommodate these differences. Some students grasp concepts quickly, while others require more time and practice. CAI addresses this challenge by adapting to individual learning styles and progress rates. It allows students to learn at their own speed, providing additional exercises for those who need more practice while offering advanced challenges for those who grasp concepts quickly. This level of customization helps cater to students' strengths while addressing their weaknesses, ultimately enhancing their confidence and performance in geometry<sup>1,2</sup>.

Immediate feedback is another key advantage of CAI that significantly contributes to effective learning. In a traditional classroom, students often have to wait for teachers to grade their work before receiving feedback, which can delay the correction of misunderstandings. CAI, on the other hand, provides instant feedback, allowing students to identify errors and correct them promptly. This immediate reinforcement not only enhances understanding but also helps students develop a problem-solving mindset. By continuously refining their approach based on instant feedback, learners become more adept at tackling complex geometric problems<sup>1,4</sup>.

Moreover, CAI offers unparalleled accessibility and flexibility, making it possible for students to engage with learning materials beyond traditional classroom hours. With the availability of online resources and software, students can revisit concepts at their convenience, reinforcing their learning outside of school. This flexibility is particularly beneficial for students who may need extra practice or those who prefer to study at different times. By providing round-the-clock access to learning tools, CAI ensures that students can reinforce their understanding of geometry whenever and wherever they choose<sup>1,2,3</sup>.

In addition to improving comprehension and accessibility, CAI plays a vital role in strengthening students' problem-solving skills. Geometry, by its nature, requires analytical thinking and logical reasoning, and CAI encourages these skills through interactive exercises and challenges. Students are often presented with problems that require them to apply geometric principles to real-world scenarios, fostering critical thinking and deeper engagement with the subject matter. By working through these exercises, students develop the ability to approach problems systematically, break them

down into manageable steps, and arrive at logical solutions—skills that are invaluable not only in mathematics but in everyday life<sup>2,5</sup>.

Furthermore, CAI incorporates multimedia resources such as videos, animations, and interactive exercises, making the learning experience more dynamic and engaging. These multimedia elements cater to diverse learning preferences, ensuring that students remain interested and motivated. For example, some students may benefit more from watching an animated explanation of a geometric theorem, while others may prefer working through interactive problem sets. By integrating various forms of media, CAI makes learning more versatile and appealing to a broader range of students<sup>3,4</sup>.

Lastly, CAI serves as a valuable support tool for teachers. While technology enhances learning, it does not replace the role of educators; rather, it complements their efforts. Teachers can use CAI to supplement their instruction by incorporating digital resources, lesson plans, and assessments into their teaching strategies. These tools help educators track student progress, identify areas where students may be struggling, and provide targeted interventions to address learning gaps. By integrating CAI into their classrooms, teachers can create a more effective and student-centered learning environment<sup>1,5,6</sup>.

The advantages of Computer-Assisted Instruction in teaching geometry are profound and far-reaching. From enhancing visual learning and promoting engagement to offering personalized instruction and immediate feedback, CAI transforms the way students interact with mathematical concepts. Its accessibility, flexibility, and ability to develop problem-solving skills make it an indispensable tool for modern education. Additionally, by incorporating multimedia resources and supporting teachers in their

instructional efforts, CAI not only improves students' understanding of geometry but also fosters a more interactive and enriching learning experience. As technology continues to evolve, its role in education will only become more integral, making CAI an essential component in shaping the future of mathematics education<sup>6,7</sup>.

#### **2.1.1.2 Disadvantages of CAI**

While Computer-Assisted Instruction (CAI) offers numerous advantages in teaching geometry, it is equally important to recognize its limitations and challenges. A balanced implementation that acknowledges these drawbacks is essential to ensure that CAI is used effectively without undermining traditional learning methods or excluding students due to resource constraints<sup>7,8</sup>.

One of the primary challenges associated with CAI in mathematics education, particularly in geometry, is the significant infrastructure requirement. Access to computers, reliable internet connectivity, and updated software is crucial for a seamless learning experience. However, in many regions—especially those with limited resources—these requirements can pose serious challenges. Schools in underprivileged areas may struggle to provide adequate technological infrastructure, leading to inequitable access to CAI. Without the necessary hardware and software, students in such areas may be at a disadvantage, widening the digital divide in education<sup>3,6</sup>.

Another concern is the potential overreliance on technology. While CAI is an excellent tool for enhancing visualization and interactive learning, excessive dependence on it may lead to a decline in traditional problem-solving skills. Geometry, like other branches of mathematics, requires students to develop the ability to solve problems using

pen-and-paper methods, construct geometric proofs manually, and understand theoretical foundations without the aid of software. If students rely too heavily on digital tools, they may struggle with written exams or real-world applications where technology is not always available<sup>1,8</sup>.

Technical issues are another common drawback of CAI-based learning. Software glitches, system crashes, or compatibility problems with different devices can interrupt lessons and create frustration among students and teachers. Such disruptions can lead to a loss of valuable instructional time, negatively impacting the learning experience. Additionally, if schools do not have dedicated IT support, resolving these technical difficulties can be a significant challenge, further discouraging the effective use of CAI<sup>2,6,8</sup>.

Beyond technical concerns, there is also the issue of learning distractions. While technology provides access to valuable educational resources, it also exposes students to potential distractions. Many students may be tempted to browse non-educational websites, play games, or engage in social media activities instead of focusing on their geometry lessons. This divided attention can significantly reduce the effectiveness of CAI-based instruction, making it essential for educators to implement monitoring tools or guidelines to minimize distractions during lessons<sup>3,7</sup>.

Another challenge is the potential isolation that prolonged CAI use may create. One of the key aspects of effective geometry learning is collaboration—students often benefit from group discussions, peer interactions, and hands-on problem-solving activities. However, excessive use of CAI can reduce face-to-face interactions and hinder social learning experiences. When students work individually on computer-based tasks

for extended periods, they may miss out on the opportunity to develop teamwork, communication, and cooperative problem-solving skills, which are essential in both academic and real-world contexts<sup>1,2,3</sup>.

Adaptability challenges further complicate the implementation of CAI. Not all students adapt well to digital learning environments. Some may struggle with navigating software, while others may feel less comfortable using technology for mathematical problem-solving. These variations in adaptability can lead to differing levels of engagement and comprehension, potentially leaving some students behind. Educators must recognize these differences and provide additional support to students who find technology-based learning more challenging<sup>1,3</sup>.

Teacher training is another critical factor that determines the success of CAI in geometry education. For CAI to be effectively integrated into classrooms, educators need proper training on how to use the technology, design effective lesson plans, and troubleshoot technical issues. However, professional development programs focusing on CAI may not always be readily available or accessible to all teachers. Without sufficient training, educators may struggle to maximize the benefits of CAI, leading to ineffective implementation and underutilization of the available resources<sup>2,7</sup>.

Cost is also a major consideration when implementing CAI in schools. The initial setup costs, including purchasing computers, acquiring software licenses, and ensuring regular maintenance, can be substantial. For many educational institutions, particularly those with limited budgets, these expenses can be prohibitive. Even when funding is available for initial investments, ongoing costs for software updates, technical support,

and infrastructure upgrades may create financial burdens that limit the sustainability of CAI programs<sup>7,8</sup>.

Finally, quality concerns must be addressed when selecting CAI resources. Not all computer-assisted learning programs are of high quality or align perfectly with national or regional curricula. Some software may provide only a superficial understanding of geometry concepts, while others may lack comprehensive coverage of essential topics. If educators rely on poorly designed CAI programs, students may receive inconsistent or inadequate instruction, leading to gaps in their understanding of geometry. It is crucial for schools and teachers to carefully evaluate and select high-quality CAI resources that align with educational standards and effectively support student learning<sup>4,8</sup>.

While CAI presents numerous opportunities to enhance geometry education, it also comes with significant challenges that must be carefully managed. Infrastructure limitations, overreliance on technology, technical issues, learning distractions, and the potential for student isolation are all factors that can affect the effectiveness of CAI. Additionally, variations in student adaptability, the need for teacher training, financial constraints, and concerns about the quality of digital resources further complicate its implementation. To maximize the benefits of CAI while mitigating its drawbacks, educators and policymakers must adopt a balanced approach—one that integrates technology thoughtfully, provides necessary support for teachers and students, and ensures equitable access to high-quality educational resources. By addressing these challenges, CAI can be leveraged effectively to enhance geometry learning while preserving the essential elements of traditional mathematical education<sup>1,7</sup>.

### 2.1.1.3 Types of Computers Assisted Instruction

Computer-Assisted Instruction (CAI) encompasses a variety of approaches designed to enhance learning through technology. Each type of CAI serves a unique purpose, catering to different learning styles and educational needs, ultimately making the learning process more engaging, effective, and adaptable. By leveraging digital tools, CAI fosters comprehension, retention, and interaction in ways that traditional teaching methods alone may not always achieve<sup>2,3</sup>.

Drill and practice CAI focuses on reinforcing specific skills or concepts through repetition. This method is particularly effective in subjects that require memorization and mastery of fundamental principles. By providing immediate feedback, it helps learners correct mistakes and reinforce learning through continuous practice. Examples include math drills for practicing arithmetic operations, spelling exercises to improve vocabulary retention, and language learning apps that assist students in mastering new words and sentence structures. The structured and repetitive nature of this approach ensures that learners build fluency and confidence in foundational skills<sup>1,4</sup>.

Tutorial-based CAI provides direct instruction on a given topic, offering explanations, demonstrations, and step-by-step guidance to facilitate learning. These digital tutorials often incorporate interactive elements, such as quizzes and exercises, to assess understanding and reinforce key concepts. Examples include interactive lessons on geometric shapes, coding software that guides beginners through programming exercises, and video tutorials with embedded quizzes that test comprehension. This approach is

especially beneficial for self-paced learning, allowing students to progress at their own speed while receiving targeted instruction<sup>2,4</sup>.

Simulations recreate real-world scenarios within a virtual environment, enabling students to explore, experiment, and learn through hands-on experiences. This type of CAI is particularly valuable in fields where practical application is crucial but real-world practice may be limited or costly. Examples include virtual science labs where students conduct chemistry experiments without physical risks, flight simulators that help trainee pilots develop critical skills before flying real aircraft, and business simulations that teach management principles through realistic decision-making exercises. By providing an immersive and interactive learning experience, simulations enhance problem-solving skills and deepen understanding<sup>3,8</sup>.

Educational games integrate learning with entertainment, making the acquisition of knowledge more enjoyable and engaging. These games are designed to motivate students while teaching specific skills or concepts through challenges, puzzles, and interactive tasks. For example, math games might require players to solve equations to advance through levels, language learning games may build vocabulary through interactive storytelling, and history games can simulate historical events, allowing students to experience different time periods firsthand. The gamification of learning enhances motivation, encourages competition, and fosters a sense of achievement, making education more dynamic and appealing<sup>1,2,7</sup>.

Multimedia presentations combine various digital elements—such as text, audio, video, graphics, and animations—to present information in a dynamic and visually appealing format. This approach caters to diverse learning styles by incorporating

multiple sensory inputs, enhancing engagement and retention. Examples include interactive textbooks that blend text with animations, educational documentaries with embedded quizzes that reinforce key points, and animated explanations of scientific concepts that simplify complex ideas. The integration of multimedia elements makes learning more immersive and helps students grasp difficult concepts with greater clarity<sup>1,7</sup>.

Hypermedia-based CAI allows students to navigate educational content in a non-linear fashion using hyperlinks. This interactive structure enables learners to explore topics at their own pace and follow their interests, making the learning experience more flexible and self-directed. Examples of hypermedia applications include educational websites that provide linked resources, digital encyclopedias that allow users to jump between related topics, and interactive e-books with multimedia enhancements such as videos, simulations, and cross-references. By offering multiple pathways to information, hypermedia fosters curiosity and deeper engagement with the material<sup>2,6</sup>.

Technology has made collaboration more accessible through CAI platforms that facilitate group learning and teamwork. These tools support communication, cooperation, and shared knowledge-building among students, regardless of their physical location. Examples include online discussion boards where students can engage in academic debates, collaborative document editing tools that allow real-time teamwork on projects, and learning management systems (LMS) that enable teachers and students to interact through forums, assignments, and group discussions. By promoting peer interaction, collaborative learning tools enhance critical thinking, problem-solving, and social learning skills<sup>1,2,6</sup>.

Distance learning, powered by CAI, enables students to access educational content remotely, breaking geographical barriers and making learning more flexible. This approach has become increasingly relevant in modern education, allowing students to pursue courses at their convenience. Examples include online courses that provide structured lessons and assessments, virtual classrooms where instructors conduct live sessions via video conferencing, and e-learning platforms that offer recorded lectures, assignments, and discussion forums. Distance learning is particularly beneficial for students with limited access to traditional classrooms, working professionals seeking additional qualifications, and institutions looking to expand their reach beyond physical boundaries<sup>2,6,7</sup>.

Each type of CAI plays a distinct role in enhancing education by leveraging technology to support diverse learning needs. While drill and practice focus on repetition and skill reinforcement, tutorials offer structured instruction. Simulations provide experiential learning opportunities, while instructional games make education engaging. Multimedia presentations and hypermedia expand access to information through dynamic content, whereas collaborative learning tools and distance learning platforms promote interaction and accessibility. By incorporating these various forms of CAI, educators can create a versatile and effective learning environment that fosters engagement, comprehension, and long-term retention of knowledge<sup>3,6</sup>.

### **2.1.2 An Overview of Mathematics Education**

Oluyole Local Government, located in Oyo State, Nigeria, is an area with a diverse educational landscape. Mathematics education, being a crucial part of the

academic curriculum, plays a significant role in the development of students' analytical and problem-solving skills. This overview examines the state of mathematics education in Oluyole Local Government, highlighting its strengths, challenges, and areas for improvement. The local government hosts numerous public and private primary and secondary schools, each contributing to the foundational and advanced stages of mathematics education. Many schools have basic facilities, including classrooms, blackboards, and textbooks. However, the availability and quality of facilities can vary significantly between urban and rural areas within the local government. Also, there is a mix of qualified and less qualified mathematics teachers. Teacher training colleges and universities in Oyo State supply a steady stream of new teachers, but ongoing professional development remains critical. The ratio can be high in public schools, which affects individual attention and the overall quality of instruction. Schools follow the Nigerian national curriculum, which outlines the mathematics content to be covered at each grade level. Geometry is a key component of the mathematics curriculum, especially in senior secondary schools, where it forms part of the preparation for national exams like the West African Senior School Certificate Examination (WASSCE)<sup>7,8</sup>.

The predominant teaching methods include lecture-based instruction and rote memorization. These methods are often criticized for not promoting deep understanding and critical thinking. Some schools and teachers are beginning to integrate more innovative teaching methods, including the use of technology, problem-solving tasks, and interactive activities. Many schools face shortages of essential teaching materials such as textbooks, geometric tools, and instructional aids. Access to computers and the internet is limited, especially in rural areas, hindering the implementation of Computer Assisted

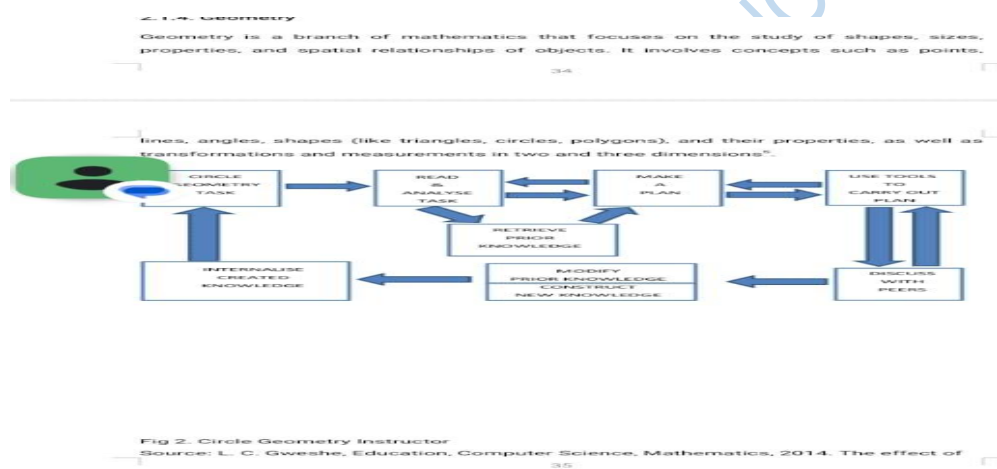
Instruction (CAI). There is a need for more continuous professional development programs to keep teachers updated with the latest teaching methodologies and technologies. Teacher motivation can be low due to inadequate salaries and working conditions, impacting their effectiveness and commitment<sup>8,9</sup>.

Student performance in mathematics, including geometry, varies widely, with many students struggling to achieve proficiency. Mathematics is often perceived as a difficult subject, leading to anxiety and a lack of interest among students. Various government programs and non-governmental organizations are working to improve the quality of education in Oluyole Local Government. These include teacher training workshops, provision of learning materials, and infrastructural improvements. Efforts are being made to integrate Information and Communication Technology (ICT) into the education system to enhance teaching and learning processes<sup>7,9,10</sup>.

Furthermore, increased parental involvement in education is being encouraged to support students' learning at home. Partnerships with private companies and educational organizations help to supplement resources and expertise in schools. Mathematics education in Oluyole Local Government is characterized by a blend of strengths and challenges. While there are significant efforts to improve the quality of education, including the adoption of innovative teaching methods and technology, there is still a considerable need for resource enhancement, teacher development, and community engagement. By addressing these challenges, the local government can foster a more effective and equitable mathematics education system that better prepares students for academic success and future careers<sup>11,12</sup>.

### 2.1.3 Geometry

It involves concepts such as points, lines, angles, shapes (like triangles, circles, polygons), and their properties, as well as transformations and measurements in two and three dimensions<sup>5</sup>.



**Figure 2.2:** Circle Geometry Instructor<sup>3</sup>

Geometry is a fundamental branch of mathematics that explores the properties, relationships, and measurements of shapes, sizes, and spaces. At its heart, geometry is concerned with understanding points, lines, angles, shapes, and their interrelations in both two-dimensional and three-dimensional spaces. It serves as a foundation for many other

areas of mathematics and has practical applications in fields ranging from architecture and engineering to art and computer graphics<sup>5</sup>.

The basic building blocks of geometry are points and lines. A point is simply a location in space with no size or dimension, while a line is a straight, one-dimensional figure that extends infinitely in both directions. These concepts form the foundation upon which more complex geometric figures are built<sup>3,4</sup>.

Angles, another crucial element of geometry, are formed when two lines intersect at a point, called the vertex. The measure of an angle tells us how much one line has rotated relative to the other, and angles are measured in degrees. Geometry also studies shapes or figures, such as triangles, circles, and polygons. Triangles, for example, are three-sided figures that come in different types, like equilateral, isosceles, and scalene, each with its own set of properties. Circles, defined by all points equidistant from a central point, are characterized by key elements like radius, diameter, and circumference. Polygons, such as squares, rectangles, and hexagons, are multi-sided figures that exhibit unique properties based on their number of sides and angles<sup>5,8</sup>.

Another essential aspect of geometry is understanding the relationships between different shapes and figures. Concepts such as congruence, which refers to figures that are identical in shape and size, and similarity, where figures have the same shape but different sizes, are vital. Geometric transformations, like translation (sliding), rotation (turning), reflection (flipping), and dilation (scaling), help explain how shapes change in position or size while preserving certain properties, such as angle measures and distances<sup>13,14</sup>.

Measurement is a critical component of geometry. It allows us to calculate areas, perimeters, volumes, and surface areas of various geometric shapes and objects. These measurements help determine the size and space that shapes occupy, which is essential in practical applications such as construction, design, and technology<sup>5,6</sup>.

In geometry, both two-dimensional (flat) and three-dimensional (solid) concepts are explored. While two-dimensional geometry focuses on shapes like squares, triangles, and circles, three-dimensional geometry deals with solids such as cubes, spheres, and pyramids. Understanding these concepts not only develops a student's mathematical skills but also enhances critical thinking, logical reasoning, and problem-solving abilities<sup>8,15</sup>.

Ultimately, geometry is more than just an abstract field of study; it has real-world relevance. Whether measuring land, designing structures, creating digital models, or solving engineering problems, the principles of geometry are integral to many areas of life. Its focus on spatial reasoning and logical structure helps students develop essential skills that are useful across multiple disciplines, making it a crucial subject in education and beyond<sup>15,16</sup>.

### **2.1.3.1 Importance of Geometry**

Geometry plays a crucial role in the academic and cognitive development of Senior Secondary School (SSS) students in Oluyole Local Government. Beyond its role in mathematics, geometry provides essential skills that are applicable in real-world scenarios, higher education, and various professional fields. Understanding these key

aspects of geometry not only improves academic performance but also equips students with critical skills necessary for their future careers<sup>2,12</sup>.

Geometry is a fundamental branch of mathematics that serves as a building block for advanced mathematical concepts. Many higher-level subjects, including trigonometry, calculus, and physics, require a solid foundation in geometric principles. The problem-solving techniques and logical reasoning skills developed through geometry enhance students' ability to approach complex problems in various disciplines, ensuring they are well-prepared for higher education<sup>4,17</sup>.

The practical significance of geometry extends beyond the classroom. Many real-world problems require geometric reasoning to find solutions. Examples include: Architecture – Designing structures and ensuring stability using geometric principles. Engineering – Applying geometry to design machines, bridges, and circuits. Surveying – Using geometric calculations for land measurements and construction planning. Navigation – Applying coordinate geometry in GPS technology and mapping. By mastering geometry, students develop problem-solving skills that are applicable in diverse fields<sup>6,12</sup>.

A strong grasp of geometry is essential for students who aspire to pursue careers in fields such as: Engineering (civil, mechanical, electrical, software); Architecture and urban planning; Graphic design and animation; Robotics and artificial intelligence; Astronomy and physics. For students in Oluyole Local Government, understanding geometry can open doors to lucrative career opportunities both locally and internationally<sup>19</sup>.

Geometry nurtures spatial awareness and reasoning, helping students: Mentally visualize and manipulate shapes. Understand and interpret 2D and 3D objects. Grasp spatial relationships between different objects. This skill is particularly beneficial in fields such as medicine (MRI imaging), video game design, and industrial design, where spatial reasoning is essential. By studying geometry, students train their minds to recognize patterns, symmetries, and structures. This ability is crucial not only in mathematics but also in: Art and design – Understanding proportions and symmetry in creative work. Physics and chemistry – Comprehending molecular structures and crystal formations. Sports and biomechanics – Analyzing movement and angles in athletic performance. Visual thinking is a skill that benefits both scientific and artistic disciplines<sup>20,21</sup>.

Geometry encourages logical reasoning, deductive thinking, and systematic problem-solving. Students learn to: Break down complex problems into smaller, manageable steps. Develop step-by-step logical proofs. Apply geometric theorems to real-world situations. These critical thinking skills are valuable beyond mathematics and can be applied in decision-making, strategy development, and analytical reasoning<sup>23</sup>.

In today's digital world, geometry plays a vital role in technology-driven industries. Students who excel in geometry gain an advantage in fields such as: Computer-Aided Design (CAD) – Used in engineering, architecture, and manufacturing. 3D Modeling and Animation – Essential in film production, gaming, and virtual reality. Artificial Intelligence and Machine Learning – Geometric algorithms play a role in facial recognition and image processing. By integrating technology and geometry, students develop skills that align with modern technological advancements<sup>19,23</sup>.

Geometry is essential for understanding measurements, angles, and spatial dimensions. Some key areas where geometry is applied include: Calculating areas and volumes – Important in construction and material estimation. Understanding angles and symmetry – Crucial in physics, design, and even medical imaging. Practical applications in daily life – Measuring distances, optimizing space, and designing objects. Mastering these measurement concepts prepares students for both academic and real-world applications<sup>18,22</sup>.

Studying geometry enhances memory, concentration, and analytical thinking, which contribute to overall cognitive growth. Engaging in geometric proofs, constructions, and visual analysis strengthens students' ability to: Identify patterns and relationships. Think logically and reason abstractly. Approach problems from multiple perspectives. For SSS students in Oluyole Local Government, these cognitive benefits extend beyond mathematics, improving performance in science, technology, and problem-solving tasks<sup>8</sup>.

The study of geometry is essential for academic success, real-world problem-solving, and career readiness. By building a strong foundation in geometric concepts, students in Oluyole Local Government gain valuable skills that enhance their logical reasoning, spatial awareness, technological proficiency, and problem-solving abilities. Teachers, parents, and educational institutions must continue to support and promote geometry education, ensuring students develop the skills necessary for both higher education and future careers<sup>8,9</sup>.

#### **2.1.4 Academic Achievement**

Academic performance refers to the evaluation of a student's achievements in a particular subject or across multiple areas of study. In mathematics, performance is often assessed through a combination of grades, test scores, problem-solving abilities, class participation, and overall comprehension of mathematical concepts. However, academic achievement goes beyond just numerical scores; it also encompasses a student's ability to apply knowledge, think critically, and engage actively in learning<sup>19,21</sup>.

One of the most common ways to measure academic performance in mathematics is through grades and standardized test scores. These assessments provide a structured way to evaluate a student's understanding of mathematical principles. Formative assessments, such as classwork, quizzes, and assignments, track a student's progress throughout a course, helping teachers identify strengths and areas for improvement. Meanwhile, summative assessments, including end-of-term exams and standardized tests, measure a student's overall grasp of mathematical concepts. Additionally, benchmark testing helps compare individual performance against established academic standards, providing valuable insights into a student's proficiency in mathematics<sup>20,22</sup>.

Beyond test scores, a student's engagement and participation in class play a crucial role in academic performance. Actively contributing to discussions, asking questions, and working collaboratively with peers demonstrate a deeper comprehension of mathematical ideas. Students who engage in classroom activities tend to develop a stronger connection with the subject, as they continuously refine their problem-solving skills through practice and discussion. The ability to explain mathematical reasoning to peers or teachers further reinforces understanding, boosting confidence and competence in the subject<sup>19,20</sup>.

Mathematical proficiency is not solely about memorizing formulas but also about understanding concepts and applying them effectively. Students who perform well in mathematics can analyze problems, recognize patterns, and use logical reasoning to arrive at solutions. Their ability to grasp abstract ideas and translate them into real-world applications—such as in measurements, financial calculations, and engineering principles—illustrates a deeper level of comprehension.

Moreover, a student's ability to retain and apply knowledge over time is a key indicator of strong academic performance. Mathematics is a subject that builds upon itself; concepts learned in one stage often serve as the foundation for more complex topics. A student who can recall and apply previously learned material demonstrates mastery and a long-term understanding of mathematical principles. This ability is particularly important in higher-level mathematics, where interconnected ideas require cumulative knowledge and logical thinking<sup>24</sup>.

Another important factor in academic performance is the development of critical thinking and analytical skills. Mathematics requires students to evaluate multiple approaches to problem-solving, assess the most efficient methods, and make logical decisions. Strong mathematical learners can identify patterns, make predictions, and apply mathematical reasoning beyond the classroom, which is essential for success in various fields, including science, technology, and engineering<sup>25</sup>.

Tracking a student's progress over time is another valuable way to assess academic achievement. A student who shows steady improvement—whether through higher test scores, increased confidence, or greater independence in solving problems—demonstrates resilience and growth. This progress is a sign that the student is actively

learning, refining their skills, and developing a deeper understanding of mathematical concepts<sup>19,25</sup>.

Academic performance in mathematics is a multi-dimensional measure that extends beyond grades and test scores. It includes conceptual understanding, problem-solving abilities, engagement, retention, critical thinking, and continuous improvement. By fostering these aspects, teachers and educators can help students develop a solid mathematical foundation that will benefit them not only in school but also in their future academic and professional pursuits<sup>24,25</sup>.

### **2.1.5 Students' Motivation**

Student motivation plays a crucial role in academic achievement in geometry, just as it does in other subjects. When students are motivated, they are more likely to dedicate time and effort to understanding complex geometric concepts, which ultimately leads to better academic performance. In the context of Computer-Aided Instruction (CAI) in geometry, motivation influences how actively students engage with learning materials, persist in solving problems, and explore geometric relationships through digital tools<sup>24</sup>.

Motivation in learning can be classified into different types, each of which affects students' engagement and success in various ways. Intrinsic motivation comes from within the student and is driven by personal interest and enjoyment in learning geometry. Students who are intrinsically motivated often engage in learning activities out of curiosity and the desire to master concepts, rather than external rewards. For many students, geometry presents an exciting challenge that stimulates logical reasoning and spatial awareness. Those who enjoy problem-solving tend to explore geometric

relationships more deeply, making connections between abstract theories and real-world applications. Additionally, interactive features of CAI, such as simulations and visualizations, make learning more engaging, encouraging students to experiment with different shapes, patterns, and theorems. These students find satisfaction in understanding and applying geometric concepts, whether in architecture, engineering, or other practical fields<sup>24,25</sup>.

While intrinsic motivation is ideal for deep learning, extrinsic motivation—driven by external factors such as grades, rewards, and social expectations—also plays a significant role in students' academic engagement. Many students strive to perform well in geometry to achieve high grades, gain recognition, or meet parental and teacher expectations. The structured nature of CAI, with built-in quizzes, progress tracking, and leaderboards, can be highly motivating for students who thrive on competition and external rewards. For instance, students may be encouraged to complete more practice exercises if they receive badges, certificates, or higher rankings on CAI platforms. Additionally, when teachers and parents set high expectations and provide positive reinforcement, students are more likely to engage actively in their learning, even if their initial motivation was not self-driven<sup>26,27</sup>.

Cognitive motivation stems from a student's natural curiosity, critical thinking skills, and desire for intellectual challenges. Some students are naturally inclined to explore mathematical concepts because they enjoy discovering patterns, solving problems, and understanding how things work. Geometry, with its emphasis on visualization, logical reasoning, and spatial manipulation, appeals to students who enjoy intellectual challenges. CAI enhances this by providing interactive problem-solving opportunities,

allowing students to test different approaches, manipulate geometric figures, and receive immediate feedback. Students who are particularly interested in technology may also find digital learning tools more engaging than traditional methods, further enhancing their motivation to learn<sup>24,28</sup>.

When students are highly motivated—whether intrinsically, extrinsically, or cognitively—they tend to take full advantage of CAI tools. They spend more time exploring interactive visualizations, engage actively in problem-solving exercises, and seek additional resources to deepen their understanding. Motivated students are also more likely to persist through challenges, using CAI features such as guided tutorials and self-assessment quizzes to overcome difficulties. Conversely, students with low motivation may struggle to engage with CAI effectively. Without a clear incentive or interest in the subject, they may rush through lessons without fully understanding the concepts, disengage from problem-solving activities, or fail to utilize the interactive features that make CAI beneficial<sup>29,30</sup>.

Motivation is a key factor in determining how effectively students learn geometry using Computer-Aided Instruction. Whether driven by intrinsic interest, extrinsic rewards, or cognitive curiosity, motivation influences how actively students engage with CAI tools and, ultimately, their academic success. Educators and parents should strive to foster motivation by making learning interactive, recognizing students' achievements, setting clear goals, and encouraging curiosity. By creating an environment that supports both self-driven and externally motivated learners, schools can maximize the benefits of CAI and enhance students' overall understanding of geometry<sup>31,32</sup>.

### 2.1.6 Students' Attitude

Students' attitudes toward Computer-Aided Instruction (CAI) play a crucial role in shaping their academic achievement in geometry. Attitudes influence motivation, engagement, and overall learning experiences, affecting how well students absorb and apply geometric concepts. A positive attitude towards CAI can enhance learning, while a negative attitude may hinder progress and limit the effectiveness of technology-based instruction. When students have a positive attitude toward CAI, they are more likely to embrace the technology, actively engage with learning materials, and apply themselves to mastering geometric concepts. Several key aspects of positive attitudes include:

**Enthusiasm:** Students who enjoy using technology often look forward to learning with CAI. The interactive and visually engaging nature of digital tools makes geometry more appealing, leading to greater interest and effort in understanding the subject. Enthusiastic students explore beyond what is taught in class, using CAI to experiment with different geometric shapes, transformations, and theorems<sup>31,32</sup>.

**Confidence:** A positive attitude often correlates with students' confidence in their ability to learn through CAI. When students believe they can successfully use computers to understand geometry, they approach learning with a growth mindset. Confidence also helps students tackle challenging topics, making them more willing to take risks, solve problems, and learn from mistakes using CAI simulations and interactive exercises.

**Perceived Relevance:** Students who recognize the real-world applications of geometry and the role of CAI in developing important skills are more likely to engage actively with digital tools. For example, understanding that geometry is essential in fields such as architecture, engineering, and computer graphics encourages students to embrace

CAI as a valuable learning resource. Seeing how technology enhances mathematical problem-solving motivates them to use CAI purposefully<sup>31,33</sup>.

While CAI offers many benefits, some students may struggle with negative attitudes that limit their ability to effectively engage with technology-based learning. These challenges include: Anxiety: Some students may feel nervous or intimidated when using computers, particularly if they lack prior experience or fear making mistakes. This anxiety can lead to avoidance behaviors, where students resist engaging with CAI platforms, missing out on valuable learning opportunities. Skepticism: Some students question the effectiveness of CAI, believing that traditional methods are superior for understanding geometry. They may doubt whether digital learning can truly replace face-to-face instruction, leading to disengagement or passive participation in CAI-based lessons<sup>33,34</sup>.

Frustration: Technical issues such as software malfunctions, slow internet connections, or difficulty navigating CAI platforms can lead to frustration. If students struggle to access materials or experience repeated disruptions, their motivation to use CAI may decrease, making them less likely to persist in learning complex geometric concepts. Resistance to Change: Students who are accustomed to traditional teaching methods may resist adopting CAI. Some prefer paper-and-pencil problem-solving and may find digital learning unfamiliar or unnecessary. Without proper guidance and encouragement, these students may disengage from CAI, limiting their exposure to interactive and dynamic learning experiences<sup>31,34</sup>.

Teachers play a critical role in fostering positive attitudes toward CAI and addressing students' concerns. To maximize the benefits of CAI in geometry, educators

can: Offering step-by-step instructions and ensuring students understand how to navigate CAI platforms can build confidence and reduce anxiety. Demonstrating how geometry and technology intersect in various careers can help students see the relevance of CAI. Encourage a Growth Mindset: Reinforcing the idea that learning through CAI involves trial and error can reduce fear of failure and motivate students to persist through challenges. Ensuring that students have access to functional devices and troubleshooting support can prevent frustration caused by technical difficulties. Combining CAI with traditional teaching methods can ease resistance, allowing students to gradually adapt to technology-enhanced learning<sup>34,35</sup>.

Students' attitudes toward CAI significantly influence their academic success in geometry. While enthusiasm, confidence, and perceived relevance enhance learning, anxiety, skepticism, frustration, and resistance can create barriers. Educators must actively support students in developing positive attitudes toward CAI by addressing challenges, providing encouragement, and demonstrating its practical benefits. When students approach CAI with an open and motivated mindset, they are more likely to engage deeply with geometric concepts and achieve academic success<sup>36</sup>.

## **2.2 Theoretical Framework**

This sets the stage for a structured exploration into the fundamental theories and concepts relevant to the topic at hand. It aims to elucidate the importance of examining existing theories, identifying gaps, contradictions, or areas requiring further investigation. Through this review, the researcher aims to provide a comprehensive overview, critically analyze different theoretical frameworks, and offer insights into their implications for the

subject area under consideration. The theories will be reviewed under the following headings: tenets, assumptions, criticisms and relevance to the study under consideration.

### 2.2.1 Cognitive Load Theory

John Sweller, an Australian educational psychologist, introduced Cognitive Load Theory (CLT) in the late 1980s, a framework that explores how the human mind processes information during learning. His work has significantly influenced the field of educational psychology and instructional design. CLT posits that human cognitive processing capacity is limited, and effective learning occurs when instructional materials are designed to manage cognitive load—essentially, the mental effort required to process information<sup>37,38</sup>.

Sweller's theory distinguishes between three types of cognitive load: Intrinsic Cognitive Load: This is the inherent difficulty of the material being learned, which is determined by the complexity of the content itself. For example, learning advanced geometric theorems is more cognitively demanding than understanding basic shapes<sup>38</sup>. Extraneous Cognitive Load: This refers to the mental effort imposed by the way the instructional material is presented. If a lesson is poorly structured or includes irrelevant information, it can unnecessarily increase cognitive load and hinder learning<sup>39</sup>. Germane Cognitive Load: This load is related to the mental effort used to process and understand the content deeply, promoting learning and schema development. Effective instructional design aims to optimize germane load while minimizing intrinsic and extraneous load<sup>40,41</sup>.

### 2.2.1.1 Tenets of Cognitive Load Theory

Sweller's work has had a lasting impact on how educational content is structured and delivered. By focusing on managing cognitive load, educators can create learning environments that reduce unnecessary mental strain and enhance student comprehension and retention. His theory has guided the development of instructional strategies, such as worked examples, scaffolded learning, and split-attention techniques, all designed to support the natural cognitive processes of students, thereby improving their learning outcomes<sup>38,40</sup>.

The core tenets of Cognitive Load Theory (CLT) revolve around understanding how the mind processes information and how instructional materials can be optimized for effective learning. CLT emphasizes that working memory has a limited capacity. It can only process a small amount of information at a time. If cognitive load exceeds this capacity, it can hinder the learning process. The theory suggests that learning efficiency depends on how well cognitive load is managed during learning tasks. Effective learning requires keeping working memory from being overwhelmed by excessive information<sup>39</sup>.

CLT posits that optimal learning occurs when the cognitive load aligns with the limitations of working memory. This means the amount of information being processed should be manageable, allowing learners to effectively organize and retain new knowledge. If the total cognitive load is too high, the learner's ability to process and store new information diminishes. Therefore, learning is most effective when instructional strategies are designed to minimize unnecessary load, focusing on the relevant content and allowing working memory to process the material efficiently. These tenets highlight the importance of designing instructional content and learning environments that respect

the cognitive limits of learners, enabling them to absorb and process information in a way that maximizes understanding and retention<sup>37,41</sup>.

### **2.2.1.2 Assumptions of Cognitive Load Theory**

Cognitive Load Theory (CLT) operates on a set of fundamental assumptions that guide the way learning experiences are designed, aiming to optimize cognitive processes and improve educational outcomes. One of the core assumptions of CLT is the idea of limited working memory. This assumption suggests that the human brain's working memory, responsible for processing and holding information temporarily, has a finite capacity. Just like a computer's short-term memory can only handle so many tasks at once, our minds can become overloaded if too much information is presented at the same time. When this happens, learners struggle to process and retain new knowledge, ultimately hindering their ability to comprehend complex material. This is why cognitive load must be carefully managed; if the load is too high, it can overwhelm the working memory, preventing effective learning from taking place<sup>39,40</sup>.

The second critical assumption of CLT is that effective instructional design is key to enhancing learning. In order to facilitate the most efficient processing of information, it is essential to reduce extraneous cognitive load—the mental effort required by factors unrelated to the learning task itself. When instructional materials are poorly designed, overly complicated, or confusing, they increase extraneous load, distracting students from the actual content they need to learn. Therefore, CLT underscores the importance of well-structured, clear, and intuitive instructional strategies. Whether through simplifying the presentation of material, breaking complex information into manageable chunks, or

eliminating unnecessary distractions, instructional design plays a crucial role in helping students learn more effectively<sup>37,41</sup>.

The third assumption of CLT is centered on schema acquisition, which is the process by which learners build mental structures, or schemas that help them organize and understand new information. When students learn, they don't simply absorb facts—they construct mental frameworks that allow them to connect new concepts to their existing knowledge. This is where prior knowledge becomes essential, as it helps students manage cognitive load by providing a foundation from which to build further understanding. Over time, as students continue to encounter new concepts and practice applying them, these schemas become automated, meaning that the cognitive load required to process them decreases. The more sophisticated a student's schemas are, the less mental effort is needed to understand new material, allowing for deeper learning and the ability to handle more complex tasks<sup>37,40</sup>.

These assumptions collectively emphasize that learning is not just about presenting information, but about creating environments and instructional experiences that respect the cognitive limitations of students. By understanding and applying the principles of Cognitive Load Theory, educators can better design lessons that foster optimal learning, reduce unnecessary mental strain, and help students develop the skills and knowledge they need to succeed<sup>38</sup>.

### **2.2.1.3 Criticisms of Cognitive Load Theory**

While Cognitive Load Theory (CLT) has been widely influential in the field of educational psychology, it has also faced several criticisms that highlight potential

limitations in its approach to understanding the complexities of human cognition and learning. One of the most prominent criticisms is that Cognitive Load Theory may oversimplify the intricacies of human cognition. Critics argue that by focusing primarily on the limitations of working memory, CLT fails to capture the full complexity of how people learn. Human cognition is not just a matter of managing limited capacity in working memory; it also involves complex processes such as attention, motivation, emotion, and individual differences in cognitive abilities. By concentrating on working memory constraints, CLT risks oversimplifying the broad spectrum of cognitive factors that influence learning. This focus on memory load may not fully account for the diverse cognitive strategies students use to approach learning or the diverse ways in which individuals process information<sup>37,39,41</sup>.

Another significant critique of CLT is its neglect of the role of motivation and emotion in the learning process. Cognitive Load Theory is primarily concerned with the mental effort required to process information and how that effort impacts learning. However, critics argue that CLT overlooks how motivation and emotion can significantly influence learning outcomes. Motivation plays a key role in whether a student engages with and persists in learning activities, while emotions—such as frustration, excitement, or anxiety—can either facilitate or hinder cognitive processing. For example, a highly motivated student might be able to overcome difficulties with a complex topic, whereas a student who feels anxious or uninterested may struggle to concentrate, regardless of how well the material is presented. By not integrating these emotional and motivational factors, CLT's approach may be seen as too narrow and may miss important influences on learning<sup>40,41</sup>.

Finally, there is a lack of consensus on how to measure and quantify cognitive load, which poses a challenge for both researchers and educators. Critics point out that the way cognitive load is assessed in CLT studies is often inconsistent, leading to discrepancies in research findings. Cognitive load is a subjective experience, and measuring it accurately can be difficult. Some studies use self-report questionnaires, while others rely on physiological measurements or behavioral observations, each of which has its limitations. Because of these methodological differences, there is no universally accepted way to measure cognitive load, which makes it difficult to draw clear, consistent conclusions from research. The lack of standardized measurement tools has led to variations in how CLT is applied in educational settings, which undermines its practical utility and generalizability<sup>37,38</sup>.

While Cognitive Load Theory has provided valuable insights into instructional design and the role of working memory in learning, its critics highlight the theory's oversimplification of human cognition, its limited focus on motivational and emotional factors, and the challenges associated with measuring cognitive load. These critiques suggest that while CLT can be a useful framework, it may need to be integrated with other theories and approaches that account for the broader, more complex nature of learning<sup>40</sup>.

#### **2.2.1.4 Relevance of Cognitive Load Theory to CAI and Academic Performance in Geometry**

Cognitive Load Theory (CLT) holds significant relevance in the design and application of Computer-Assisted Instruction (CAI), particularly when applied to the teaching of geometry. The core principles of CLT offer valuable insights into how CAI

can be tailored to optimize students' learning experiences and improve their academic performance, especially among senior secondary school students in Oluyole Local Government. By understanding and applying CLT, educators can create more effective instructional tools that cater to students' cognitive capacities, ensuring better comprehension of geometric concepts and enhancing overall academic achievement<sup>37,38</sup>.

One of the primary ways in which Cognitive Load Theory can influence CAI design is through the effective management of cognitive load. CLT emphasizes the importance of minimizing extraneous cognitive load—the unnecessary mental effort that detracts from learning—while maximizing germane cognitive load, which directly contributes to the construction of knowledge. When designing CAI tools for teaching geometry, understanding this balance is crucial. Instructional materials that are overloaded with irrelevant information, poorly structured, or overly complex may overwhelm students, hindering their ability to process and retain geometric concepts. On the other hand, CAI tools that streamline content delivery and present information in a manner that is both clear and engaging can help students focus their cognitive resources on understanding core concepts, leading to improved academic performance<sup>38,39</sup>.

In addition to optimizing the design of CAI materials, Cognitive Load Theory also supports the development of adaptive learning systems. By utilizing CAI systems that are informed by CLT principles, instruction can be tailored to meet the individual needs of students in geometry. Adaptive learning systems dynamically adjust the difficulty and complexity of tasks based on the learner's progress and cognitive load, ensuring that students are not overwhelmed by tasks that are too challenging or disengaged by tasks that are too simple. For senior secondary students in Oluyole Local

Government, this approach can be particularly beneficial, as it allows for personalized learning experiences that align with their unique cognitive abilities, pacing, and comprehension levels. By fostering a learning environment where students are appropriately challenged without feeling frustrated, adaptive CAI systems can enhance motivation, engagement, and, ultimately, academic achievement in geometry<sup>37,40,41</sup>.

Furthermore, the application of Cognitive Load Theory allows for the evaluation of instructional materials used in CAI for geometry teaching. Through the lens of CLT, educators can assess whether the instructional content is effectively managing cognitive load for students. CAI tools can be scrutinized for their ability to present geometric concepts in a structured and coherent manner that facilitates learning rather than overwhelming the student's cognitive resources. This evaluation process ensures that the tools used in geometry instruction are not only pedagogically sound but also conducive to the optimal cognitive processing required for effective learning<sup>38,39</sup>.

The relevance of Cognitive Load Theory to the design and implementation of CAI in geometry education cannot be overstated. By understanding and applying CLT principles, educators can enhance the effectiveness of their instructional tools, making them more adaptable to students' needs and better suited to promoting deeper learning. For senior secondary school students in Oluyole Local Government, this approach can significantly impact their ability to comprehend and apply geometric concepts, leading to improved academic performance and a stronger foundation for future academic and professional pursuits<sup>37,41</sup>.

### **2.2.2 Constructivism Theory**

Constructivism Theory is a prominent educational theory that emphasizes the active role of learners in constructing their own understanding and knowledge. The theory posits that learning is not a passive process where students simply absorb information; instead, they actively build upon their prior experiences and understanding through interaction with their environment, social contexts, and educational experiences. Several key figures have made substantial contributions to the development and refinement of Constructivist theory, each adding their unique perspective on how individuals learn<sup>42,43</sup>.

One of the foundational figures in Constructivism is Jean Piaget, a Swiss psychologist who is widely regarded as the architect of cognitive development theory. Piaget's work, which began in the 1920s and continued through the mid-20th century, focused on how children develop cognitive structures to make sense of the world around them. Piaget believed that learning is a process of active construction, where learners build their knowledge through interaction with their environment and through stages of cognitive development. He introduced the concepts of schemas, assimilation, and accommodation to describe how learners integrate new information into their existing mental frameworks. Piaget's theory emphasized that learners must actively engage with their surroundings, experiment, and reflect on their experiences to make sense of the world<sup>42,44</sup>.

Another key figure in the development of Constructivism is John Dewey, an American philosopher and educator. Dewey is often recognized for his contributions to experiential learning. Dewey believed that education should not simply focus on the transmission of knowledge from teacher to student but should prioritize the experiences

of the learner. He argued that meaningful learning occurs when students actively engage in problem-solving, experimentation, and critical thinking. Dewey's views were groundbreaking in that he emphasized the social and contextual nature of learning. For Dewey, education was not just about acquiring knowledge but also about preparing students to live in a democratic society, making his work highly influential in both educational theory and practice<sup>43,44</sup>.

Lev Vygotsky, a Russian psychologist, introduced the concept of the Zone of Proximal Development (ZPD), a core principle in Constructivist theory. Vygotsky's work focused on the social and cultural aspects of learning. He argued that cognitive development is deeply embedded in social interactions and that learning occurs most effectively when students engage with others, such as teachers or peers, in guided interactions. Vygotsky's ZPD emphasizes the gap between what a learner can do independently and what they can achieve with the help of a more knowledgeable individual. He believed that learning is most effective when teachers provide the necessary scaffolding, offering support and guidance to students as they navigate tasks just beyond their current capabilities. This framework highlights the social nature of learning and underscores the importance of collaborative learning environments<sup>45</sup>.

Finally, Jerome Bruner, an American psychologist, contributed significantly to the development of Constructivist theory through his ideas on discovery learning and scaffolding. Bruner's work emphasized that learners should be encouraged to explore and discover concepts on their own rather than passively receiving information. He argued that students learn best when they are actively engaged in the learning process, constructing their own understanding through problem-solving and exploration. Bruner

also introduced the idea of scaffolding, which refers to the support given to learners that is gradually reduced as they become more capable. His emphasis on the importance of active learning and student autonomy resonated deeply with the Constructivist perspective<sup>46</sup>.

Together, Piaget, Dewey, Vygotsky, and Bruner laid the foundations for the theory of Constructivism, each emphasizing the active role of the learner in constructing knowledge. Their work has had a profound influence on education, particularly in the design of learner-centered environments that encourage exploration, problem-solving, and collaboration. Constructivist teaching methods prioritize student engagement, critical thinking, and social interaction, making them highly effective for fostering deep understanding and lasting learning outcomes.

#### **2.2.2.1 Tenets of Constructivism Theory**

Constructivism Theory, as a prominent educational framework, revolves around several core principles that highlight the active, dynamic, and social nature of learning. These principles are grounded in the belief that learners are not passive recipients of information, but rather active participants in constructing their own understanding and knowledge. Central to Constructivism is the idea that learning is an active process. Learners are not mere vessels to be filled with knowledge; instead, they are active constructors of their understanding. They engage with content, explore ideas, and interact with their environment in meaningful ways. As learners encounter new experiences and challenges, they actively work to make sense of them, integrating them into their existing knowledge base. Through this hands-on engagement, students move beyond

memorization and develop deeper, more meaningful connections with the material they are learning<sup>44,46</sup>.

Constructivism asserts that learners build their own mental representations or schemas of knowledge. This process of construction is driven by exploration, inquiry, and reflection. Rather than passively receiving information from a teacher or textbook, students actively engage in problem-solving and critical thinking activities that encourage them to question, analyze, and reflect. This approach leads to a deeper understanding, as learners are encouraged to link new information to prior knowledge and experiences, refining their mental models over time. In this sense, learning is seen as a process of ongoing construction, where each new experience adds layers to the learner's understanding.

Constructivism emphasizes the importance of social interaction in the learning process. Collaborative learning environments, where students work together, share ideas, and engage in dialogue with peers and teachers, are fundamental to this theory. According to Constructivism, learners refine and expand their understanding not only through their individual experiences but also through meaningful exchanges with others. These interactions contribute to shaping their thought processes, encouraging critical thinking, and providing opportunities for different perspectives. Vygotsky's concept of the Zone of Proximal Development (ZPD) and the idea of scaffolding highlight the importance of social support in helping learners progress beyond their current abilities. By engaging in discussions, debates, and collaborative problem-solving, students refine their understanding and construct new knowledge in ways they might not achieve in isolation<sup>44,46</sup>.

Together, these tenets underscore the core principles of Constructivism: that learning is an active, individual, and social process. Students are not passive recipients of knowledge but active participants in their learning journey, constructing their understanding through direct experiences, reflective inquiry, and collaboration with others. This approach fosters deeper, more engaged learning, promoting critical thinking, problem-solving, and a sense of ownership over one's educational progress<sup>42,43</sup>.

#### **2.2.2.2 Assumptions of Constructivism Theory**

Constructivism Theory is built on several foundational assumptions that shape how learning occurs, particularly in subjects like geometry. These assumptions emphasize the importance of the learner's background, the role of the environment, and the dynamic nature of knowledge acquisition. One of the core assumptions of Constructivism is that learners come to the learning process with prior knowledge and experiences. This prior knowledge plays a crucial role in shaping how new information is understood, interpreted, and integrated into existing mental frameworks. In the context of geometry, for example, a student's previous understanding of basic shapes, numbers, and spatial reasoning influences how they will approach more complex geometric concepts. Constructivist teaching, therefore, emphasizes building upon what learners already know and using their existing knowledge as a foundation to explore and understand new material. This assumption highlights the importance of assessing students' prior knowledge to design learning experiences that connect with their individual learning histories and cognitive abilities<sup>44,45,46</sup>.

Constructivism places significant importance on the learning environment and its role in facilitating knowledge construction. Learning is most effective when it occurs within a context that encourages active engagement, exploration, and problem-solving. In a geometry classroom, this assumption suggests that students should be provided with real-world contexts and problems that require them to actively participate in discovering geometric principles and concepts. By engaging in hands-on activities, such as manipulating geometric shapes, creating models, or solving practical geometry problems, students can develop a deeper understanding of the material. The learning context should be rich in opportunities for students to explore, inquire, and make meaning of the content themselves. It should promote curiosity, allow for experimentation, and encourage students to confront and resolve challenges in a way that fosters independent thought and critical thinking<sup>43,46</sup>.

Together, these assumptions emphasize that learning is a personal and active process that is influenced by the learner's prior knowledge and experiences and is best facilitated in a supportive and stimulating learning environment that promotes exploration and meaningful engagement. By incorporating these assumptions, educators can design geometry lessons that not only cater to the cognitive needs of students but also create an environment where students are empowered to construct their own understanding and actively engage with new knowledge<sup>44,46</sup>.

### **2.2.2.3 Criticisms of Constructivism Theory**

While Constructivism has been a highly influential and transformative educational theory, it has faced several criticisms, particularly regarding its application in diverse learning contexts and its impact on instructional practices. These criticisms revolve around concerns related to the nature of knowledge, assessment, and the need for structured guidance in the learning process. One of the primary criticisms of Constructivism is its emphasis on subjective interpretations of knowledge. Critics argue that by focusing heavily on the individual construction of knowledge, Constructivism risks undermining the existence of an objective reality. This can lead to relativism, where different interpretations and understandings of concepts are seen as equally valid. In educational contexts, particularly in subjects like geometry, this could create confusion and ambiguity, as students might develop varying interpretations of geometric principles without a common, universally accepted foundation. Critics fear that this approach could ultimately result in a lack of consensus and shared understanding, especially in disciplines that rely on objective facts and universally accepted truths<sup>42,45</sup>.

Another significant criticism of Constructivism is the challenge it presents in measuring and assessing learning outcomes. Constructivist approaches, which focus on individualized learning and context-specific understandings, make it difficult to develop standardized assessments that effectively measure students' comprehension of the material. Traditional testing methods, such as multiple-choice questions or standardized exams, often fail to capture the depth and complexity of students' learning experiences in a constructivist classroom. Since the approach emphasizes personal meaning-making and discovery, it can be challenging to assess the full range of skills and knowledge that students develop. Consequently, critics argue that Constructivism may not always

provide reliable or consistent metrics to evaluate academic performance, particularly in subjects like geometry, where precise understanding and application of principles are crucial<sup>43,46</sup>.

Critics also contend that purely constructivist approaches may sometimes provide insufficient guidance or structure for learners, especially in subjects that are traditionally seen as more structured, like mathematics. While the theory advocates for students to take an active role in their learning and discover knowledge on their own, it may leave them without the clear frameworks or scaffolding that are often necessary to master complex concepts. In the case of geometry, for instance, students may struggle with abstract concepts or the application of geometric rules if they do not receive sufficient direct instruction, examples, or step-by-step guidance from the teacher. Without appropriate support and direction, students might find themselves overwhelmed or confused by the intricacies of the subject matter. Critics argue that a balance must be struck between providing students with the freedom to explore and ensuring they have enough structured learning opportunities to make meaningful progress<sup>42,45,46</sup>.

While Constructivism offers a valuable perspective on how learning occurs, especially in terms of fostering independent thought and critical inquiry, it is not without its limitations. Critics emphasize the need for careful consideration of the balance between subjective interpretation and objective knowledge, the challenges of assessing learning outcomes in a constructivist framework, and the potential for insufficient guidance in certain academic contexts, such as mathematics and geometry. These criticisms highlight the importance of adapting Constructivist principles to the specific needs and challenges of different subjects and student populations<sup>42,46</sup>.

#### **2.2.2.4 Relevance of Constructivism Theory to CAI and Academic Performance in Geometry**

Constructivism Theory offers a valuable lens through which Computer-Assisted Instruction (CAI) can be enhanced to improve academic performance, especially in subjects like geometry. By emphasizing active learning, prior knowledge, social interaction, and personalized learning experiences, Constructivism can inform the design and implementation of CAI tools that effectively support students' understanding and application of geometric concepts. In the context of senior secondary school students in Oluyole Local Government, integrating Constructivist principles into CAI can provide numerous benefits for geometry education<sup>8,21,46</sup>.

One of the most significant contributions of Constructivism to CAI design is the creation of interactive and exploratory learning environments. Constructivism asserts that learning is most effective when students actively engage with the content rather than passively receiving information. In the case of geometry, CAI tools that incorporate interactive features, such as virtual manipulatives, geometric visualization tools, and dynamic simulations, allow students to explore geometric shapes, relationships, and properties firsthand. Students in Oluyole Local Government, by interacting with CAI systems, can experiment with different geometric transformations, visualize abstract concepts, and discover mathematical truths through trial and error. This process aligns with Constructivism's emphasis on learners constructing their knowledge through exploration and active engagement<sup>24,42</sup>.

Another key aspect of Constructivism is its recognition of individual differences in prior knowledge and learning styles. Applying these principles to CAI systems can

result in adaptive and personalized learning experiences. CAI tools that integrate Constructivist principles can be designed to assess students' current understanding of geometry and adapt the learning path accordingly. For example, a CAI platform might present a student with different geometric problems or provide additional resources based on their current level of comprehension. This personalized approach ensures that students receive content that is neither too difficult nor too easy, helping them build on their existing knowledge while fostering a deeper understanding of geometry. In Oluyole Local Government, where students may come from diverse backgrounds and have varied levels of prior knowledge, this adaptability ensures that each student receives instruction tailored to their unique learning needs<sup>25,46</sup>.

Constructivism highlights the importance of social interaction and collaborative learning in the construction of knowledge. In a geometry classroom, peer collaboration can significantly enhance learning, especially when students discuss and explain geometric concepts to one another. CAI systems that incorporate collaborative features—such as discussion forums, group projects, and peer feedback—allow students to engage in dialogue with their classmates, share ideas, and collaboratively solve geometric problems. By working together, students can refine their understanding of geometric principles, learn from each other's perspectives, and enhance their critical thinking skills. In Oluyole Local Government, where students may face challenges in fully grasping abstract geometric concepts, collaborative learning opportunities provided by CAI platforms can help bridge gaps in understanding and encourage a deeper engagement with the subject matter<sup>19,45</sup>.

Constructivism Theory's focus on active learning, prior knowledge, social interaction, and personalized learning aligns closely with the capabilities of Computer-Assisted Instruction. By integrating these principles into the design of CAI tools for geometry, educators can create engaging, interactive, and adaptive learning experiences for senior secondary students in Oluyole Local Government. These experiences can significantly improve students' understanding and academic performance in geometry by enabling them to actively construct their knowledge, collaborate with peers, and receive personalized instruction that caters to their individual learning needs. Through the application of Constructivist principles, CAI becomes a powerful tool for enhancing the educational experience and promoting academic success in geometry<sup>22,44</sup>.

### **2.3 Review of Empirical Studies**

A study compared and contrasted computer-aided education with other teaching technologies while highlighting the value of computers in mathematics instruction<sup>42</sup>. According to study findings from 320 students and 8 faculty members at a university, The CATL system enhances student performance and teacher-student communication. Other methods are unable to achieve the 94.43% performance rate that the CTL achieves. Thus, the study proposed educational techniques to improve learning sustainability with computer-assisted instruction and learning system (CATL). The suggested approach is a crucial concept to put into practice and use by utilizing the teaching and learning experiences of individual teachers. One strategy to improve the effectiveness and sustainability of education is through the CATL system framework. Since computer

education is essential for all learners, the study suggested that it is included in school curriculum.

A study investigated the Teacher's Geometry Vocabulary Competence and Students' Academic Performance in Circle Theorem<sup>43</sup>. In this study, 210 students were chosen using the probability systematic sampling methodology, and a sequential explanatory design was employed along with a mixed-methods research approach. Along with the primary data collection, which included the use of a questionnaire, an achievement test, and an interview guide, a complete literature study was carried out. Regression analysis and deductive manual theme analysis, which was limited to the qualitative data obtained from the interviews, were employed to analyze the field data. The study discovered a strong correlation between the dependent variable (students' academic achievement in Circle's Theorem) and the independent variable (teachers' language skills and vocabulary knowledge). This suggests that the teacher's vocabulary knowledge and circle theorem linguistic ability affect the students' performance in the theorem. In order to improve teachers' language proficiency and vocabulary related to the circle theorem, it is advised that the Ghana Education Service host training conferences and workshops. Additionally, the Mathematics Syllabus should include instructions on how students should be introduced to mathematical terminology and vocabulary.

A study looked into how mathematics achievement among Rivers State secondary school pupils was affected by computer-assisted instruction<sup>44</sup>. Two inquiries for research and two Researches were directed by hypotheses. It was a quasi-experimental design. 215 senior students made up the study's population. Gokana secondary school Kpor. The study's sample was 35 pupils. Simple random was used to determine the sample size. The

tool utilized to gather information was achievement test with multiple choice questions. The device underwent validation by scholars and specialists in computer science education. And 0.81 was established as the instrument's dependability. Utilizing the mean and standard deviation, the pre-test and post-test results to address research inquiries, whereas the z-test was utilized to evaluate the theories at 0.05 significant level. The study's conclusions demonstrated that pupils receiving computer-assisted education outperformed those receiving traditional training teaching strategies. Additionally, results showed that there is a notable distinction between the pre- and post-tests performance levels of pupils instructed in mathematics with computer-assisted teaching approach. The research suggested believe the government ought to incorporate computer and integrating instructional software into maths classrooms junior secondary school curriculum as this will aid in preparing pupils for exceptional math performance at upper secondary school.

Another study looked at how Delta State senior high school pupils' retention and achievement in geometry were affected by the Frizbi Mathematics 4 computer-assisted instruction program<sup>45</sup>. A quasi-experimental pre- and post-test study approach was used in the research. The study's population consists of all SS2 students enrolled in public secondary schools for the academic year 2018–2019. Two schools were chosen using the purposeful sampling technique based on the fact that their school is the only one having a computer lab. After that, basic random was used. Using a sampling technique, a sample size of 110 was chosen and split into Experimental and groups under control. The experimental group's students used CAI software, but those Geometry was taught in the control group using a conventional teaching methodology. The instruction took place over a period of four weeks. Following that, both groups took the Geometry Achievement

Retention Test, a research tool. The results attained were assessed at the 0.05 level of significance using the mean, standard deviation, and t-test. The outcome demonstrates that the average accomplishment and retention scores of the participants differ significantly from one another the groups under experimentation and control. The experimental group benefited from the observed difference collective. The investigation also showed that there is no discernible variation in the mean scores for achievement and retention among students using CAI software, both male and female regardless of sex. It follows that gender bias is not present in CAI. Thus, the investigation concluded that the CAI-Frizbi Mathematics 4 program significantly improves Geometry retention and achievement among senior school students. Thus, among other things, it suggests that math teachers need to be motivated to utilize the CAI Frizbi Mathematics 4 program in the geometry instruction in secondary education.

A study examined how SSS in Katsina, Katsina State, Nigeria performed in geometry when they received CAI<sup>46</sup>. The study looked at the retention and achievement scores of students who received computer-assisted instruction and individuals who were instructed using traditional means. There were twenty senior high school students in the sample. Pupils were selected from Katsina's two secondary schools. To choose, stratified random sampling was employed. The 20 pupils, consisting of 10 men and 10 women. Three hypotheses and three research questions were developed, and the significance threshold was assessed at 0.05. The 40-item GAT items of the multiple-choice objective type that the researcher created and approved were utilized as a tool for gathering data. A test called the Geometry Achievement Test (GAT) was given to students as pre-test and post-test. To evaluate the hypotheses, the t-test statistic was used to assess the student

outcomes. The findings showed that students who were taught using the CAI outperformed their peers who were taught using the conventional style of instruction. In a retention test, pupils who were taught with CAI outperformed the control group. Additionally, it was discovered that the post-test performance scores of male and female students who were taught using the CAI package did not differ significantly. It was suggested, in light of the results, that computer-aided instruction be promoted in the schools for the teaching and learning of geometry and mathematics.

A study investigated the impact of CAI on mathematical achievement in mainland China using meta-analysis<sup>46</sup>. The study found 36 studies that met the strict inclusion requirements, totaling 13,438 students in grades 1 through 12. Overall, they had a moderate effect ( $ES=+0.38$ ) relative to conventional training. This result appeared to corroborate the reasoning behind the recent curriculum changes in China's mainland, specifically that CAI yielded superior outcomes when paired with fresh approaches to instruction. Even Transmission-CAI and Supplemental-CAI were more effective than conventional transmission instruction.

Another study x-rayed how mastery learning affected the retention and achievement of circle geometry in senior secondary school pupils<sup>47</sup>. The research was carried out in Nigeria's Kwara state, at Ilorin. It used non-randomized, quasi-experimental, pre- and post-test designs for the control groups. A sample of 172 pupils in senior high school II was selected using a multi-stage selection process from four coeducational schools. The Circle Geometry Achievement Test served as the data gathering tool (CGAT). This was confirmed by professionals, yielding a dependability index of 0.82 when test-retest methodology. The outcome demonstrated that senior

school pupils' performance improved in circle geometry when taught utilizing mastery method of learning. When using a mastery learning technique, there was no discernible difference in the achievement of low, medium, and high scoring students based on gender. In the post-test, there was also a significant difference mean score and retention score of pupils instructed in mastery circle geometry method of learning. Among other things, it was suggested that trainings should be provided to math teachers on the efficient application of the mastery learning approach if improved performance is needed in the mathematics classroom.

A study examined how technology is implemented significantly impacts classroom management. The rapid advancement of technology has made its use in classrooms unavoidable<sup>49</sup>. As technology evolves and expands, it changes how it is utilized in educational settings. In technology-aided education based on a behavioral approach, traditional lectures are enhanced, and student motivation is increased. Conversely, in a classroom shaped by a constructivist approach, there is a greater emphasis on student-centered activities, which leads to changes in classroom management techniques. Many students struggle with understanding fundamental concepts in geometry and often leave geometry classes without learning basic terminology. Systematic teaching of geometry can improve students' knowledge and success by boosting their motivation. This study aims to demonstrate the role of technology-based teaching in enhancing student motivation and to explore whether the use of technology in the classroom can improve geometry learning.

A study combined experimental studies that compare the effectiveness of technology-assisted teaching with traditional methods on mathematical and geometry

achievement using a meta-analytical review method<sup>50</sup>. It examines articles, master's theses, and doctoral dissertations conducted in Turkey from 2000 to 2016. A total of 98 studies on academic achievement met the criteria and were included in the meta-analysis. The effect size between variables was calculated by numerically combining the findings from these studies, using CMA 2.0 and MS Office Excel 2010 for data analysis. The meta-analysis results show that the effect size of technology-assisted teaching on students' mathematics achievement is 0.758, and on geometry achievement is 1.136. These values represent a medium effect size for mathematics achievement and a very large effect size for geometry achievement, although both are considered medium according to Cohen's standards. The study also calculated comparative effect sizes based on implementation techniques, education levels, and learning fields. The findings indicate that technology-assisted teaching is more effective than traditional methods for improving achievement in mathematics and geometry. Additionally, the effect size on academic achievement in these subjects does not vary based on implementation time, education level, or learning fields.

A study examined the use of Geogebra Software in Teaching Mathematics. The advent of computer technology has created opportunities and facilitated its use in various aspects of life, including education, as a supportive tool<sup>51</sup>. One such program beneficial for mathematics learning is Geogebra software. The researcher employed the documentation method to collect data and analyzed it using content analysis. After reviewing twelve relevant articles highlighting the benefits of Geogebra in mathematics education, several significant findings emerged. These include the ease with which

students understand geometry using Geogebra and their increased enjoyment of learning geometry through this computer-operated software.

A study examined the effects of using dynamic geometry on eighth grade students' achievement and attitude towards triangles<sup>52</sup>. The study involved a controlled experiment with experimental and control groups, both taught by the same teacher. Thirty-six eighth-grade students from a rural middle school in Turkey participated, none of whom had prior experience using computers for learning mathematics. The results indicated that dynamic geometry-based computer instruction significantly improved students' geometry achievement compared to traditional methods. Additionally, this type of instruction positively influenced students' attitudes toward geometry and technology. A correlation analysis revealed a positive relationship between students' achievement levels and their attitudes toward both geometry and technology.

A study investigated geometry as a crucial component of the mathematics curriculum, numerous studies indicate that many students in Turkey do not achieve the necessary level of geometric understanding<sup>54</sup>. The project-based learning approach is considered one of the most effective methods to create an environment where students can derive their own conclusions rather than just receiving lectures. This study investigated the effects of project-based learning on seventh-grade students' geometry achievement and their attitudes towards the subject. Student surveys, interviews, teacher observations, and researcher observations also suggested that project-based learning enhanced achievement and attitudes by involving students in model-making, solving real-life problems, and using trial and error to determine dimensions and areas. This approach

particularly benefited high-capacity students who were easily distracted during traditional classes by engaging them in projects they felt ownership of, leading to positive outcomes.

A study examined the impact of dynamic geometry CAI on eighth-grade students' geometry achievement and their attitudes toward geometry and technology, compared to traditional teaching methods<sup>55</sup>. The study involved a controlled experiment with experimental and control groups, both taught by the same teacher. Thirty-six eighth-grade students from a rural middle school in Turkey participated, none of whom had previous experience using computers for learning mathematics. The findings showed that dynamic geometry CAI significantly improved students' geometry achievement compared to traditional methods. Additionally, this instruction positively influenced students' attitudes toward geometry and technology. A correlation analysis revealed a positive relationship between students' achievement levels and their attitudes toward both geometry and technology.

A study investigated the impact of integrating STEM practices into Science courses for 6th-grade middle school students on their academic achievement toward STEM<sup>56</sup>. The research was conducted during the 2018-2019 academic year with a population consisting of 6th-grade students from a middle school. Using a quasi-experimental design, both experimental and control groups underwent pre-tests and post-tests comprising an ACT, STEM Problem Solving Inventory. Statistical analysis was performed using a software package. The results indicated that students in the experimental groups, who received STEM practices, achieved higher scores on the Academic Achievement Test compared to the control group that followed a constructivist

approach. This difference was found to be statistically significant. Additionally, improvements were observed in the post-test scores of the STEM.

A study examined Students' attitude and academic achievement in a flipped classroom. The study employed a quasi-non-equivalent, the attitudes towards chemistry and academic achievements of second-year Bachelor of Education students specializing in Chemistry were examined using the flipped classroom strategy<sup>57</sup>. The study involved 100 students who initially completed a 30-item questionnaire to assess their attitudes towards chemistry. Pre-tests were conducted for both the control and experimental groups. Subsequently, the experimental group experienced instruction via the flipped classroom method, while the control group received traditional teaching. Following this, the experimental group took a post-attitude test. Post-tests were administered to both groups. Results indicated a significantly higher mean in the post-attitude test scores compared to the pre-test scores, suggesting a positive shift in students' attitudes towards chemistry with the use of the flipped classroom strategy. Academic achievement was also assessed, revealing that students taught with the flipped classroom strategy achieved significantly higher than those taught conventionally. These findings suggest that the flipped classroom approach can enhance students' attitudes towards chemistry and improve their academic performance. This study holds particular relevance for chemistry education in secondary and tertiary institutions in developing countries like Nigeria, where high student-to-teacher ratios often challenge effective classroom instruction

A study explored the effects of integrating local wisdom forms into a MAR application on the learning attitude, motivation, and understanding of geometry concepts among pre-service mathematics teachers<sup>58</sup>. The study involved 24 participants and

utilized an embedded design with mixed methods. Instruments included questionnaires to assess attitude and motivation, a geometry concept understanding test, and semi-structured interviews. Data were analyzed both quantitatively and qualitatively. The findings indicate that integrating local wisdom into MAR applications for learning geometry was effective, yielding positive impacts on the attitude, motivation, and comprehension of geometry concepts among pre-service mathematics teachers.

A study examined the use of augmented reality (AR) technology in middle school settings to teach Geometry. The researchers developed an AR application for students to learn fundamental geometric concepts, alongside a similar web-based application targeting the same educational goals. They used a  $2 \times 2 \times 2$  factorial design involving 93 participants to analyze how technology type (web vs. AR), school type (private vs. public), and assessment timing (pre-test vs. post-test) influenced motivation and knowledge retention. The findings revealed that: (1) there was an interaction effect between technology type, school type, and assessment timing on students' achievement scores; (2) students utilizing the AR application performed better in the post-test compared to those using the web-based version; (3) the AR learning environment was more effective for students in public schools, but not for those in private schools; (4) no interaction effect was found regarding motivation across the different factors; (5) students in private schools reported higher motivation levels when using the AR environment compared to their public school counterparts. The results suggest that, in Mexico, AR technology can be effectively utilized to support middle school students from both public and private schools in learning the fundamental principles of Geometry.

A study examined the connection between students' attitudes toward mathematics and their achievement in the subject has been a focal point for researchers, although findings on this relationship have varied<sup>59</sup>. Using latent profile analysis on data from the 2019 Trends in International Mathematics and Science Study in Singapore, we identified four distinct attitude profiles: very negative (5.44%), negative (41.38%), neutral (38.77%), and positive (14.41%). Our analysis affirmed that attitudes toward mathematics encompass multiple dimensions such as liking mathematics, valuing mathematics, and confidence in mathematics. Additionally, we found a positive correlation between students' attitudes toward mathematic.

A study examined Students' Attitude toward Mathematics and its Relationship with Mathematics Achievement. Mathematics is essential in fields like Science, Technology, and Engineering, where all subjects are heavily math-oriented<sup>61</sup>. However, preliminary studies have linked students' performance in Mathematics to three main factors: interest, attitude, and learning habits, as outlined in the KASH Model. This model suggests that poor academic outcomes stem not only from lacking knowledge and skills but also from negative attitudes and ineffective study habits. This study aims to explore the levels of interest, attitude, and learning habits among students based on the KASH Model and examine their relationships. The sample consisted of 58 students enrolled in subjects like Thermodynamics, Fluid Mechanics, and Solid Mechanics. Data were collected using a questionnaire with 21 items, and descriptive analysis was employed to determine means, percentages, and Pearson correlations. The findings revealed high levels of interest, positive attitudes, and effective learning habits among the students, with significant correlations observed between interest, attitude, and habits. The

study underscores the importance of nurturing these variables equally during teaching and learning processes to enhance students' achievement, particularly in Mathematics subjects.

A study evaluated the impact of DGS on students' mathematical abilities; and identify conditions under which the use of DGS is most effective in enhancing students' mathematical skills<sup>62</sup>. This meta-analysis reviewed 57 effect sizes extracted from 50 articles published between 2010 and 2020 in academic journals and international and domestic conference proceedings. Comprehensive Meta-Analysis (CMA) was utilized for data analysis, calculating effect sizes using the Hedges coefficient with a 95% confidence level. The random effects model yielded an overall effect size of 1.07, indicating a substantial positive impact of DGS on students' mathematical abilities. This effect size suggests that, on average, students using DGS perform better than 84% of their peers in traditional classrooms with similar starting abilities. Analysis of study characteristics revealed significant variations based on sample size, student-to-computer ratio, and educational level. Specifically, DGS was found to be more effective in smaller sample sizes (30 or fewer students), settings with adequate access to computers allowing individual student use, and at higher education levels such as high schools and colleges compared to junior high schools. These findings provide insights to educators, guiding decisions on optimal sample sizes, student-to-computer ratios, and educational levels when implementing DGS in mathematics education.

A study examined the effectiveness of dynamic geometry software applications in learning mathematics. Mathematics Connections, a core secondary mathematics curriculum funded by the National Science Foundation in 1992, aims to introduce

advanced mathematical concepts to all students<sup>63</sup>. It portrays mathematics as a crucial, powerful, and adaptable tool essential for engaging with the world at various levels, from everyday scenarios to cutting-edge scientific and technological frontiers. The program was developed with five primary goals by principal investigators, developers, and an Advisory Council. Professional development plays a critical role in effectively implementing Mathematics Connections. Classes using Mathematics Connections exhibit notably higher levels of student engagement compared to those using traditional curricula. The program's philosophy and design aim to equip students with the skills necessary for reasoning, communication, problem-solving, and critical thinking.

A study examined the effects of Mathematics Connections on student achievement, confidence, and perception Standards-based school mathematics curricula. In modern education, there is a recognized need for changes in teaching and learning methods to address current societal demands<sup>64</sup>. This study focuses on evaluating the effectiveness of a collaborative learning approach, centered around the Harry Potter theme, compared to traditional methods in teaching geometric figures to first-year students in Obligatory Secondary Education mathematics. The research employs a quasi-experimental, quantitative, descriptive, and correlational design, utilizing standardized questionnaires for data collection. The sample comprises 236 students from a public high school in Cádiz, Spain, distributed among eight groups (four experimental and four control). Findings indicate that collaborative learning enhances both student attitudes and mathematical comprehension. The collaborative method, infused with the Harry Potter theme, fosters a more positive student outlook on the learning process in mathematics at the first-year level of Secondary Education. Moreover, it supports the acquisition of

geometric mathematical concepts, although the impact on actual grades is minimal despite slightly better performance observed in the experimental group compared to the control group.

A study examined the effect of CSCL using GeoGebra software on 11th grade students' mathematics achievement in exponential and logarithmic functions<sup>65</sup>. This study aimed to assess the impact of computer-supported collaborative learning (CSCL) utilizing GeoGebra software on the academic performance of 11th-grade students in exponential and logarithmic functions. It employed a quasi-experimental design with both pre-test and post-test assessments conducted among two groups: an experimental group (18 students) and a control group (17 students) in Istanbul, Turkey. The experimental group engaged in CSCL activities facilitated by GeoGebra software, whereas the control group received traditional textbook-based instruction. Data collection utilized a mathematics achievement test (MAT) comprising 20 multiple-choice items developed by the researchers, administered as both a pre-test and a post-test to both groups. Findings indicated that CSCL using GeoGebra software significantly enhanced students' achievement in understanding exponential and logarithmic functions compared to traditional instructional methods.

A study examined the Role of Students' Beliefs, Parents' Educational Level, and The Mediating Role of Attitude and Motivation in Students' Mathematics Achievement<sup>66</sup>. The study randomly selected 30 classes from six schools in Surabaya, Indonesia, involving 894 fifth- and sixth-grade students (448 boys and 446 girls). Using SEM, the study found that this model predicts 49% of the variance in students' mathematics achievement. Beliefs positively correlate with achievement ( $\beta = 0.20$ ,  $p < 0.001$ ), attitude

( $\beta = 0.82$ ,  $p < 0.001$ ), and motivation ( $\beta = 0.68$ ,  $p < 0.001$ ). Parents' educational level also positively correlates with achievement ( $\beta = 0.17$ ,  $p < 0.001$ ) and motivation ( $\beta = 0.07$ ,  $p = 0.04$ ). Beliefs indirectly influence achievement through attitude ( $\beta = 0.31$ ,  $p < 0.001$ ) and motivation ( $\beta = 0.08$ ,  $p = 0.01$ ). However, the indirect effect of parents' educational level on achievement through motivation was found to be insignificant. This study contributes valuable insights into understanding the intricate relationships among beliefs, parents' educational background, attitudes, motivation, and academic achievement.

A study investigated the impact of GeoGebra on three-dimensional geometry learning on students' overall mathematical communication skills and specifically among groups categorized by their prior mathematical abilities<sup>67</sup>. Conducted as a quasi-experimental study with a randomized posttest-only design, the research involved 84 twelfth-grade students from a high school in Central Jakarta, Indonesia. Prior to the study, students were classified into high, medium, and low ability groups based on their mathematical skills. Data collected included results from a mathematical communication skills test comprising 7 questions, which were analyzed using the Mann-Whitney test. The findings indicate differences between students who received GeoGebra-assisted geometry learning and those who received traditional mathematics instruction. Overall, as well as among students with high and medium prior mathematical abilities. However, no significant differences were observed among students with low prior mathematical ability.

A study investigated the impact of using GeoGebra software within aCSCL environment on seventh graders' geometry achievement, learning retention, and attitudes toward geometry. Utilizing a quasi-experimental design, the research involved a pretest, post-test, and delayed post-test, and was conducted with 62 seventh-grade students in

Turkey<sup>68</sup>. The experimental group engaged in CSCL activities with GeoGebra, while the control group received traditional textbook-based instruction. Both groups completed the GAT and the GAS as pretests and post-tests, with a retention test administered eight weeks later. Data analysis was performed using SPSS 17.0 through t-tests and ANCOVA. The findings indicated that the CSCL approach with GeoGebra significantly improved students' geometry achievement and learning retention compared to traditional instruction. Additionally, it was found that this learning environment positively influenced students' attitudes toward geometry.

A study assessed the impact of using GeoGebra in conjunction with the ARCS model (Attention, Relevance, Confidence, and Satisfaction) on students' academic achievement and motivation<sup>69</sup>. The research involved both an experimental group and a control group. To evaluate motivation, the academic motivation questionnaire developed by Harter (1981) was utilized. Additionally, two sets of multiple-choice tests on a geometry topic were created to measure students' academic achievement. Pre-tests were administered to both groups at the start of the lessons. The experimental group received instruction through GeoGebra, while the control group was taught using traditional methods. Post-tests were given to both groups at the end of the lessons. The statistical differences in post-test scores for academic motivation and achievement between the two groups were analyzed using ANCOVA after confirming the assumptions of normality and homogeneity. The results indicated that the experimental group outperformed the control group in both academic achievement and motivation.

A study explored the factors influencing high school students' GPS abilities, involving 101 Indonesian students<sup>70</sup>. Participants were divided into two groups based on

the learning approach (LA) used: the investigative learning group and the direct instruction group. Data were collected using three types of instruments: the test of Basic Geometric Concepts (BGC), the Geometry Problem-Solving (GPS) assessment, and the Mathematics Self-Efficacy (MSE) scale, which includes MTSE and MSSE. The researchers analyzed the data using ANOVA techniques, path analysis, and error analysis. The findings indicated that the levels of BGC and MTSE, along with the interactions between learning approaches and gender, significantly affected students' GPS capabilities. Specifically, students' BGC levels impacted their MSE, which in turn hindered their GPS skills, with gender and learning approaches acting as moderators. The analysis identified phases in the problem-solving process that negatively affected student performance; female students tended to focus on visualization, while male students preferred representation. The researchers recommend further studies on gender-based learning approaches in the geometry curriculum to enhance student abilities.

A study investigated the impact of integrating PowerPoint on motivation and achievement among students in under-resourced SHSs<sup>71</sup>. The research utilized an embedded mixed-method approach with a quasi-experimental design, involving 80 students randomly selected from two government-supported SHSs, who were divided into control and experimental groups. To gather data, teacher-created Pre- and Post GAT were administered, along with semi-structured interviews for qualitative insights. The experimental group received instruction using Information and Communication Technology (ICT) through PowerPoint presentations, while the control group was taught using traditional instructional methods. Both groups completed the pre-GAT and post-GAT assessments, and their responses were scored to generate quantitative data. The

findings revealed that students in both groups showed improvement in their post-GAT scores compared to their pre-GAT results.

This meta-analysis evaluated the overall impact of using GeoGebra software and assessed how study characteristics influence effect sizes, which has implications for future research. The analysis included 36 effect sizes from 29 primary studies<sup>72</sup>. To ensure accurate calculations, CMA software was utilized. The effect size was calculated using the Hedges equation, with 0.5% level significance. The findings indicated that the overall effect size of GeoGebra on students' mathematical abilities was 0.96, based on a random-effects model, with a standard error of 0.08. This suggests that, on average, students who engaged in GeoGebra-based learning outperformed their peers in traditional classrooms, with their performance comparable to 82% of those students. The study examined five specific characteristics and found that GeoGebra was particularly effective in samples of 30 or fewer students. Additionally, providing a sufficient number of computers in the classroom for individual student use was crucial for achieving greater effectiveness. Furthermore, GeoGebra software proved to be more effective when the duration of the intervention was four weeks or less.

These findings provide valuable insights for educators regarding the study characteristics that influence effect sizes when using GeoGebra software in the future<sup>73</sup>. Another study investigated the effectiveness of GeoGebra software in Rwandan secondary schools for teaching geometry concepts. Using a quasi-experimental design, the research involved four purposefully selected schools—two from the Northern Province and two from Kigali City. A geometry-based test comprising 15 open-ended questions was created to evaluate the teaching impact before and after geometry

instruction. Conducted from December 2020 to June 2021, the study included 87 students, with two schools designated as control groups and the other two as experimental groups, each consisting of one school from Kigali and one from the Northern Province. Data analysis was performed using SPSS, employing multivariate analysis of variance. The results indicated that students who learned with GeoGebra significantly outperformed those who did not. The study advocates for the integration of GeoGebra in all mathematics teaching and learning activities.

A quasi-experimental study was conducted to evaluate the impact of using GeoGebra software as a teaching aid on the achievement of Form Two students. The study involved 80 Form Two students, with 40 in the treatment group and 40 in the control group<sup>74</sup>. The results revealed significant differences in student achievement related to the topics of functions and limits, depending on the group type. Additionally, both teachers and students expressed support for using GeoGebra in mathematics instruction. The software effectively illustrates mathematical concepts and procedures through visuals and graphs, significantly aiding students in understanding functions and limits. GeoGebra is user-friendly and can alleviate the burden on teachers when explaining these concepts. Although using the software can be time-consuming, it promotes a more active learning process for students. Furthermore, incorporating GeoGebra fosters active interaction between teachers and students. This study also offers recommendations for interventions aimed at enhancing student achievement.

In today's technology-driven world, it is essential to incorporate teaching methods that engage students and align with their interests. This study examines the role of GeoGebra in mathematics education, highlighting its potential to enhance student interest

and achievement while accommodating various learning styles<sup>75</sup>. Additionally, the study addresses important considerations to keep in mind before implementing GeoGebra-integrated lessons, including challenges, limitations, and areas for future development. Key challenges identified include users' beliefs and technological proficiency, as well as the student-to-teacher ratio, which can hinder effective integration of GeoGebra into math lessons. Furthermore, the complexity of certain commands in the input bar poses limitations, particularly for students and teachers without prior programming experience.

A study determined the effect of Computer-Assisted Instruction on students' academic performance and retention in chemistry concepts among senior secondary school students in Kankia, Katsina State-Nigeria<sup>81</sup>. The study had two research objectives, two research questions and two null hypotheses. A total number of 123 students consisting of 78 males and 45 females were selected using Simple random sampling techniques formed the sample for the study. The study adopted the pretest, posttest, and post post-test quasi experimental and control group design. The subjects in the experimental group were taught using Computer-Assisted Instruction (CAI), while the control group was exposed to lecture method for a period of six weeks. One validated research instrument, with reliability coefficient of 0.88, namely chemistry Performance Test (CPT), was used in data collection. Two null hypotheses were tested using t-test statistic at  $P \leq 0.05$  level of significance. The major findings from the study revealed that there is significant difference in the posttest mean performance scores of experimental and control groups in favour of experimental group. Furthermore, students exposed to Computer-Assisted Instruction had higher level of retention ability in learning chemistry concept than lecture group. The study found CAI an effective teaching method. Based on that findings

emanating from this study it was recommended that federal and state governments should adequately train Chemistry teachers on using Computer-Assisted Instruction in teaching chemistry among others.

The indispensability and vast career possibilities associated with Chemistry notwithstanding, there is a palpable growing decline enrollment in Chemistry in Nigerian universities, particularly the private universities<sup>88</sup>. The paper interrogated the teaching and learning of Chemistry in Nigerian private universities with a view to re-awakening the students' interest for effective mastery of the subject. It relied on secondary sources and critical analysis and found out that major inhibiting factors include: Students' faulty foundation in Chemistry, syndrome of area of concentration, absence of competitiveness in the admission process, poor attitude of students and lecturers as well as the ambience for effective scholarship. The paper concluded that the current downturn in the students enrolment in Chemistry and the seemingly poor interest in the subject portend sufficient threat to the future of Chemistry, chemical-related industries and the replacement of ageing Chemistry lecturers in Nigeria. It recommended the following strategies to mitigate the vicious cycle: targeted tutorial system, adoption of digital modes of teaching and learning, problem-based learning, capacity building initiatives for Chemistry lecturers, quality assurance mechanism, overhauling science education at the primary and secondary school levels, need-based assessment and provision of quality materials as well as adequate funding.

Motivation is an essential factor influencing learners' active participation in STEM subjects and their decision to study STEM fields<sup>83</sup>. This study aimed to determine the current state of research on motivation and STEM and systematically review the

current research in the literature. The study examined 78 articles published in journals indexed in the SCOPUS database. Two researchers collected and analyzed the data using the content analysis method. The results showed that the first research on motivation and STEM were published in 2008, and most research papers were published in 2021. The results also showed that most studies were conducted in the United States (47.8%), and the preferred participants were undergraduates (28.1%), high school students (26.7%), and middle school students (14%), respectively. In addition, the results revealed that researchers primarily used the quantitative method to collect data, and a substantial ratio of the studies (83%) investigated student-level factors. Based on the results obtained from this study, it can be concluded that there is a need to comprehensively present the main research results on motivation in STEM education. We suggest that future research should examine databases such as ERIC, ProQuest, and Web of Science and include other documents in the analysis, including book chapters, conference papers, dissertations, and theses.

One study investigated the effects of Computer-Assisted Instruction (CAI) on students' achievement in Chemistry among boys and girls in public secondary schools in Ondo State<sup>79</sup>. A quasi-experimental design was adopted for the study. The sample for the study consisted of 240 senior secondary school two (SSS II) intact class Chemistry students selected in stages using simple random sampling technique. Three schools were selected from three local government areas from the three senatorial districts in Ondo State. The students in the experimental groups were exposed to CAI while the control group was taught with the conventional teaching method. Chemistry Achievement Test (CAT) with a reliability coefficient of 0.81 was used to collect relevant data for the study.

The experimental group was treated using CAI package while the control group was treated using the conventional classroom teaching. Analysis of Co-variance (ANCOVA) and t-test were used to test the research hypotheses at 0.05 level of significance. The result from the study showed that there was no significant difference between the achievement of male and female students in both the experimental and the control groups respectively. The results showed that when exposed to CAI, female students performed better than their counterparts. Based on the findings of the study, it could be concluded that the use of CAI has not shown any better effectiveness in the achievement of students. However, the method is a modern day of imparting knowledge. In another dimension, when both males and females are taught with the use of CAI, the method appeared to favour females than males. This suggests that the method is gender-biased. Based on the findings of the research, it is recommended that the potential of computer-assisted instruction should be utilised to enhance better achievement of the students in Chemistry, most especially among females while the male students also be encouraged to key into the use of the method for the flexibility of teaching and learning.

A study investigated the effect of Computer-Aided Instruction (CAI) on the performance of Senior Secondary School Students in Geometry in Katsina, Katsina State, Nigeria<sup>44</sup>. The study examined the significance of retention achievement scores of students taught using computer-aided instruction and those taught using the traditional method. The sample consisted of twenty senior secondary school students drawn from two secondary schools in Katsina. Stratified random sampling was used to select the 20 students (10 males and 10 females). Three research questions and three hypotheses were formulated, and tested at 0.05 level significance. Geometry Achievement Test (GAT)

made up of 40 items of multiple-choice objective type, developed and validated by the researcher was used as an instrument for data collection. The Geometry Achievement Test (GAT) was administered to students as pre-test and post-test. The results of students were analyzed using t-test statistic to test the hypotheses. The results indicated that students taught using (CAI) performed significantly better than their counterparts taught using the traditional method of instruction. Similarly students taught using CAI performed better than the control group in retention test. It was also found that there was no significant difference in the post-test performance scores of male and female students taught using CAI package. Based on the findings it was recommended that Computer-Aided Instructions be encouraged for teaching and learning of Geometry and mathematics in our schools.

A Research aimed to determine the effect of implementing a Computer-Assisted Instruction on secondary physics students' academic achievement<sup>87</sup>. The research utilized the quasi experimental pretest-posttest control group design that is participated by 157 Grade 10 students of a private school in the Philippines. The experimental group was taught using the Computer-Assisted Instruction while the control group was instructed using the conventional method of teaching Physics. Mann-Whitney test with a significance level of 0.05 was used in comparing the difference between pretest scores of the control and experimental groups, the difference between the pretest and posttest scores of the control group and experimental group, and Z test with a significance level of 0.05 was utilized in comparing the mean gain scores of both groups to determine the effect of the CAI. The findings of the study show that both CAI and conventional methods of teaching improve the level of performance of students in physics significantly.

However, when the effectiveness of the two methods is compared, there is no significant difference between their effects on academic achievement. Therefore, CAI could be used as an alternative teaching method.

One study investigated the effects of Computer Assisted Instruction (CAI) on learning outcome in science subjects (Chemistry & Physics) among secondary school students in Kogi state<sup>86</sup>. Quasi-experimental, pre-test, posttest, nonrandomized control group design was adopted for the study. One research question and corresponding hypothesis guided the study. The population of the study consists of 2,228 senior secondary two (SS2) students and an intact class size of 241 participants were purposively used for the study. Computer Assisted Instruction in both subjects Chemistry (CAIC) and Physics (CAIP) serves as the treatment while two research instruments Chemistry and Physics Achievement Test (CAT & PAT) were used to collect data for the study. The instruments were validated with a reliability index of 0.83 using the test-retest technique and Kuder Richardson formula 20(K-R20). The collected data was analyzed using mean and standard deviation for the research questions and T-test for the research hypotheses at 0.05 level of significance. The result shows significant difference in learning outcomes among the two subjects, with the greatest academic achievement score in physics and chemistry trail behind. It was recommended among others that Computer Assisted Instructions be embedded with Animation to take care of chemistry abstractive nature for a better result.

A study examined how the use of Computer Aided Instruction (CAI) in secondary schools affects the academic performance of undergraduate students in Bayelsa State<sup>85</sup>. The study was guided by three research objectives and questions respectively and two

research hypotheses. It adopted the analytical descriptive survey, a sample population of 1000 undergraduate students were selected and used for the study through the proportionate stratified random and simple random sampling technique. Secondary data of students' result was used to analyze academic performance and the questionnaire was also used for data collection designed under the four-point Likert scale, it was validated with reliable coefficient of 0.63 using the split half method. Research questions were analyzed using weighted mean, while the hypotheses were tested using student t-test at 0.05 significant level. The hypotheses were rejected. Findings show that the use of CAI improves students' academic performance. The study recommends the provision of CAL software, capacity training of teachers to improve their selection and use of CAI in teaching and the encouragement of research on CAI among undergraduates.

Mobile applications (m-Apps) have been recognized as a powerful tool in teaching and learning of Mathematics. Proper usage of m-Apps would enhance students' and teachers' effectiveness in the classroom setting<sup>84</sup>. This study examined the acceptance and perception of students and teachers on the use of mobile application in teaching and learning of Mathematics. The study adopted descriptive research design of a survey type. The sample for this study consisted of three hundred (300) respondents consisting of fifty (50) Mathematics and science subject teachers and two hundred and fifty (250) Senior Secondary School year one (SSS1) students randomly selected from five (5) public secondary schools in three Local Government Areas of Ogun-East Senatorial District in Ogun-State, Nigeria. The sampling technique used in this study was a simple random sampling. The only instrument used for data collection was titled "Acceptance and Perception on Mobile-Apps Questionnaire". The reliability of the

instrument was determined using Cronbach alpha and a reliability coefficient of 0.764 was computed. Four research questions were answered. Data collected were analyzed using the descriptive statistics of mean, standard-deviation and percentages. The result of the study revealed that teachers are more perceptive than the students about the use of mobile-Apps in teaching and learning of Mathematics. Furthermore, the result of the study showed that there is a high-level acceptability automobiles by teachers and students in teaching and learning of Mathematics. It was recommended, among others, that teachers of Mathematics should be sent to seminars, workshops, and conferences to update their pedagogical skills and strategies for innovative and fruitful delivery in the classrooms.

A Research aimed to determine the impact of blended learning on the performance of science students and their self-regulation and to identify effective recommendations to improve the effectiveness of blended learning<sup>82</sup>. Third-year students of Kazan Federal University took part in the study. The measurement scale tools adopted in this study included pre-test, post-test and self-regulation questionnaires. Analyses showed that participants in the experimental group scored higher on the final test than students in the reference group. The experimental group scored significantly higher than the reference group on the self-regulation questionnaire. It can be concluded that the blended learning model can significantly improve students' self-regulation compared to the traditional approach to learning. Recommendations were made to improve blended learning.

A study determined the effect of Computer-Assisted Instruction on students' academic performance and retention in chemistry concepts among senior secondary

school students in Kankia, Katsina State-Nigeria<sup>81</sup>. The study had two research objectives, two research questions and two null hypotheses. A total number of 123 students consisting of 78 males and 45 female selected using Simple random sampling techniques formed the sample for the study. The study adopted the pretest, posttest, and post post-test quasi experimental and control group design. The subjects in the experimental group were taught using Computer-Assisted Instruction (CAI), while the control group was exposed to lecture method for a period of six weeks. One validated research instrument, with reliability coefficient of 0.88, namely chemistry Performance Test (CPT), was used in data collection. Two null hypotheses were tested using t-test statistic at  $P \leq 0.05$  level of significance. The major findings from the study revealed that there is significant difference in the posttest mean performance scores of experimental and control groups in favour of experimental group. Furthermore, students exposed to Computer-Assisted Instruction had higher level of retention ability in learning chemistry concept than lecture group. The study found CAI an effective teaching method. Based on that findings emanating from this study it was recommended that federal and state governments should adequately train Chemistry teachers on using Computer-Assisted Instruction in teaching chemistry among others.

Another study determined effects of computer assisted instructional mode on varied ability groups among Junior Secondary School Students in social studies<sup>80</sup>. The theories that have basis for Computer Assisted Instruction have been explored in order to establish the theoretical base for this research. Purposive sampling technique was used to select six co-educational schools for the research. The study adopted the pretest – posttest experimental – control group design. A sample of two hundred and forty (240)

students were drawn from six Junior Secondary Schools in seven educational zones of Niger State. Two research questions were raised and two null hypotheses were tested at 0.05 alpha level. Data were collected and analyzed. The result of hypothesis one indicated that there was statistically significant difference between the ability of students taught Social Studies using Computer Assisted Instructional mode and those taught with conventional lecture method. While hypothesis two showed that there was no significant difference between the achievements of high, medium and low ability of students taught Social Studies with Computer Assisted Instructional mode. Iowa's therefore recommended among others that, Students of different ability levels should use the CAIMOSOS individually in order to improve their learning achievement since the package has been found to improve learning irrespective of ability levels.

A study determined the effects of computer assisted instructional mode on achievement level of Junior Secondary School Students in social studies<sup>78</sup>. Three research questions were raised and three null hypotheses were tested at 0.05 alpha level. The study adopted the pretest-posttest experimental-control group design. A sample of two hundred and forty (240) students were drawn from six Junior Secondary Schools in seven educational zones of Niger State. The zones are located within the three senatorial zones in the state. Purposive sampling technique was used to select six coeducational schools for the research. The researcher developed computer assisted instructional package on social studies which was used as treatment instrument for the experimental group while the control group was exposed to conventional lecture method. The instruments for data collection were Social Studies Achievement Test (SOSAT). A forty item multiple-choice objective type questions were used for the SOSAT. A reliability coefficient of 0.95 and

0.95 were obtained for the instruments using split-half method. For instance, the result of hypothesis one indicated that there was statistically significant difference in the achievement of students taught Social Studies using Computer Assisted Instructional mode and those taught with conventional lecture method. While hypothesis four showed that there was no significant difference in the achievement scores of male and female students taught Social Studies with Computer Assisted Instructional mode. It was recommended among others that, for effective teaching and learning in Junior Secondary Schools in Niger State and the country at large, government should as a matter of urgency supply government schools with all the necessary instructional media such as Computer assisted instructional mode on social studies (CAIMOSOS) in order to enhance effective teaching and learning of Social Studies.

Another study determined the impact of blended learning on the performance of science students and their self-regulation and to identify effective recommendations to improve the effectiveness of blended learning<sup>82</sup>. Third-year students of Kazan Federal University took part in the study. The measurement scale tools adopted in this study included pre-test, post-test and self-regulation questionnaires. Analyses showed that participants in the experimental group scored higher on the final test than students in the reference group. The experimental group scored significantly higher than the reference group on the self-regulation questionnaire. It can be concluded that the blended learning model can significantly improve students' self-regulation compared to the traditional approach to learning. Recommendations were made to improve blended learning.

A study examined Motivation and Academic Achievement of Students' toward sustainable national development in Nigeria with reference to College of Education

Waka-Biu, Borno State<sup>88</sup>. Two research questions were raised to guide the study. The descriptive survey research design was used. The target population was NCE two (400) and NCE three (420) students covering Economics department from the Schools of Arts and social science. 200 respondents were purposively sampled. 21-item of research instrument based on a 5-point Likert scale was tagged through the Motivation for Academic Achievement Questionnaire (MAAQ). Data collated were analyzed using simple frequency and mean. The finding of the studies concludes that intrinsic and extrinsic motivation in a proper blend has the potency to improve students' academic achievement in Economics. The study finally recommends among others that, students should be concertized as well as be empowered to realize that they played the most important role in motivating themselves first toward sustainability, before anyone else; and economics alongside other teaching subject areas to be made interesting so as to arouse and sustain students' interests and enhance learners' achievement motivation.

Science education is attracting increasing attention and many researchers focus on the issue about the attitude-achievement relationship in science, but there is still no consistent conclusion. By using a three-level meta-analytic approach, the aim of the study was to investigate the relationship between attitude toward science and academic achievement in learning science among primary and secondary school students, and to explore if some study characteristics could have contributed to the inconsistent findings with regard to this relationship as observed in the research literature<sup>90</sup>. A total of 37 studies with 132 effect sizes a total of 1,042,537 participants were identified. The meta-analytic results revealed that there was an overall positive and moderate relationship between attitude toward science and learning achievement in science ( $r = 0.248$ ,  $p <$

0.001). The results further found that this association was moderated by the type of attitude and larger effect sizes were shown in self-efficacy than in interest, societal relevance of attitude toward science, and mixed attitude. Moreover, the effect sizes of studies with unstandardized measure to assess science achievement were larger than those with standardized measure. Possible explanations for these findings and its implications for future research directions were also discussed in this review.

A study investigated peer group influence as a correlate of secondary school student's motivation towards learning in Oluyole Local Government area of Ibadan. The main purpose of the study is to determine the influence of peer group as a correlate of secondary school student's motivation towards learning<sup>93</sup>. In specific terms, the study is designed to determine whether peer group influence secondary school students' motivation towards learning, the factors that can determine student's motivation towards learning, whether peer group influence determines variation in Academic Performance of male and female students, whether age does determine the extent to which peer influence affects Academic Performance of students, just to, mention a few. The researcher employed descriptive survey method for the study. The population for the study was based on all the fifty two (52) secondary schools under Oluyole local government area of Oyo state; consisting of twenty seven (27) public secondary schools and thirty two private secondary schools. Sampling techniques used were multistage, stratified and simple random sampling technique.

A multistage sampling technique was used due to two stages involved in selecting the sample. At the first stage, schools are stratified into public and private, and simple random sampling technique was used to select ten public secondary schools out of twenty

seven and ten private schools out of thirty two which make a total of twenty schools. At the second stage, a simple random sampling technique was used in selecting only ten student's from the selected secondary schools from both private and public secondary schools, five from junior secondary school and five from Senior Secondary School in Oluyole Local Government area in Ibadan making a total of two hundred students. A pilot survey was carried out by administering the research instrument to ten randomly selected students who were not part of the selected respondents after which the instrument was subjected to analysis and a cronbach Alpha value 0.757 was obtained. Descriptive statistical tool such as mean and standard deviation were used to analyse the obtained data to answer three questions while person product moment correlation was used to analyze Hypotheses 1 and T-test was used to analyze Hypotheses 2 and 3. All analyses were carried out at 0.05 level of significance.

The perceived motivation status of secondary school students towards learning is higher through the weighted mean of 3.24. Peer influence on the academic motivation of secondary school students towards learning is high at 2.89. Peer group influence on secondary school students' academic motivation is high at 3.02. There is significant relationship between peer group influence and secondary school students' motivation towards learning at 0.005. There is no significant gender difference in peer group influence of secondary school student's motivation towards learning at 0.958. There is no significant school type difference in secondary students' academic motivation towards learning at 197. It is recommended that students should move with peer groups that will motivate them towards learning.

A study aimed to implement integrated learning of local wisdom forms in Mobile Augmented Reality (MAR) application and analyze their impact on learning attitude, learning motivation and Geometry concept understanding of pre-service mathematics teachers<sup>94</sup>. The subjects of this study were 24 pre-service mathematics teachers. This study uses an embedded design of the Mix-method. The instruments in this study were questionnaires (attitude and learning motivation), Geometry concept understanding test, and semi-structured interview. The data were analyzed quantitative and qualitatively. The finding covered that learning geometry by integrating local wisdom form in MAR application was effective and gave a positive impact on the attitude, motivation, and geometry concept understanding of pre-service mathematics teachers.

There are several concepts in 2D Geometry that require understanding their application in the real practical world. However, in classrooms, such concepts are often taught without the analysis of the learners' realization and interpretation of the existing concepts around them, in their surroundings. For this purpose, an Augmented Reality (AR) based module for the 7th and 8th grade syllabus has been designed to encourage the active participation of the learners in the classroom while learning the concept of Lines and Angles<sup>95</sup>. It comprises three AR learning activities that enable the participants to recall, visualize, and identify the type of angle and then mark it by drawing on the augmented 3D house. Before conducting the main studies, a pilot study was conducted with 6 students of 8th grade. This helped in validating the data instruments, timing, and execution of the research study. The first study was conducted with 21 students of 8th grade where 12 participants performed the AR learning activities in dyads and 9 participants performed individually. Their perspectives, approaches, and motivation in

performing the AR learning activities have been reported. Findings from the study showed that the majority i.e. 90.4% participants preferred to perform the AR learning activities in dyads than individually. Though the usability score was higher for the participants who performed the AR learning activities individually ( $M = 70.28$ ) as compared to dyads ( $M = 65.23$ ), there was no significant difference in the motivation scores between the participants of the two groups. In the second study, 28 students of 7th grade were divided into dyads and their behavior patterns of performing the AR learning activities have been reported. Using Lag Sequential Analysis, significant sequences were obtained based on the behaviors belonging to three categories of peer involvement, teacher prompts and AR interactions. It was found that the designed AR learning activities encouraged the participants to discuss the concepts with peers, enhanced their immersive experience as they together moved around and inside the house to find and identify the angles.

Another study investigated gender differences in pre-service teachers' attitude towards geometry in Northern Region of Ghana<sup>96</sup>. The research design was descriptive cross-sectional survey. A concurrent mixed-methods approach was adopted using both closed and open-ended questionnaire items. The population for the study was one thousand, six hundred and sixty-nine (1669) level 200 Pre-service Teachers (PSTs). The sample composed of two hundred and forty (240), comprising 120 PSTs each of female and male. The sampling procedure was convenient, stratified and simple random. The instrument used was 32 item Utley Geometry Attitude Scales (UGAS) that was developed by Utley (2007) and 4 opened ended questions. Statistically significant difference was detected between the male and female in their responses to usefulness of

learning geometry, confidence to learning geometry and enjoyment of learning geometry which all favored the male PSTs who showed positive attitude towards geometry.

It has been discovered that incorporating technology into geometry instruction improves students' abilities and attitudes. GeoGebra Software is effective at motivating teachers to use technology as a supplement to enhance students' mathematical learning potential. Another study sought to ascertain the effects of GeoGebra software on secondary school students' performance as well as teachers' and students' attitudes toward 3-dimensional geometry<sup>97</sup>. A sample of 84 Senior Five students in upper secondary school from Kicukiro and Musanze District was chosen purposively. The selected sample was divided into two groups for the quasi-experimental design, with the control group having 44 students and the experimental group having 40 students. Additionally, two teachers were chosen to involve in the study. Students in the experimental group used GeoGebra software to study 3D geometry, whereas students in the control group received traditional geometry instruction. The data was collected quantitatively, with both groups taking pre-and post-tests. The obtained data were analyzed using SPSS v.25.

The results revealed a statistically significant difference in students' performance between the groups in favour of the experimental group. Furthermore, both teachers' and students' attitudes were improved. These findings support GeoGebra's efficacy in increasing student achievement as well as teachers' and students' attitudes toward 3-D geometry. However, there was no statistically significant difference in attitudes between male and female students, according to the study. Therefore, we advise adding GeoGebra to mathematics curricula across all grade levels in Rwanda, with a focus on geometry.

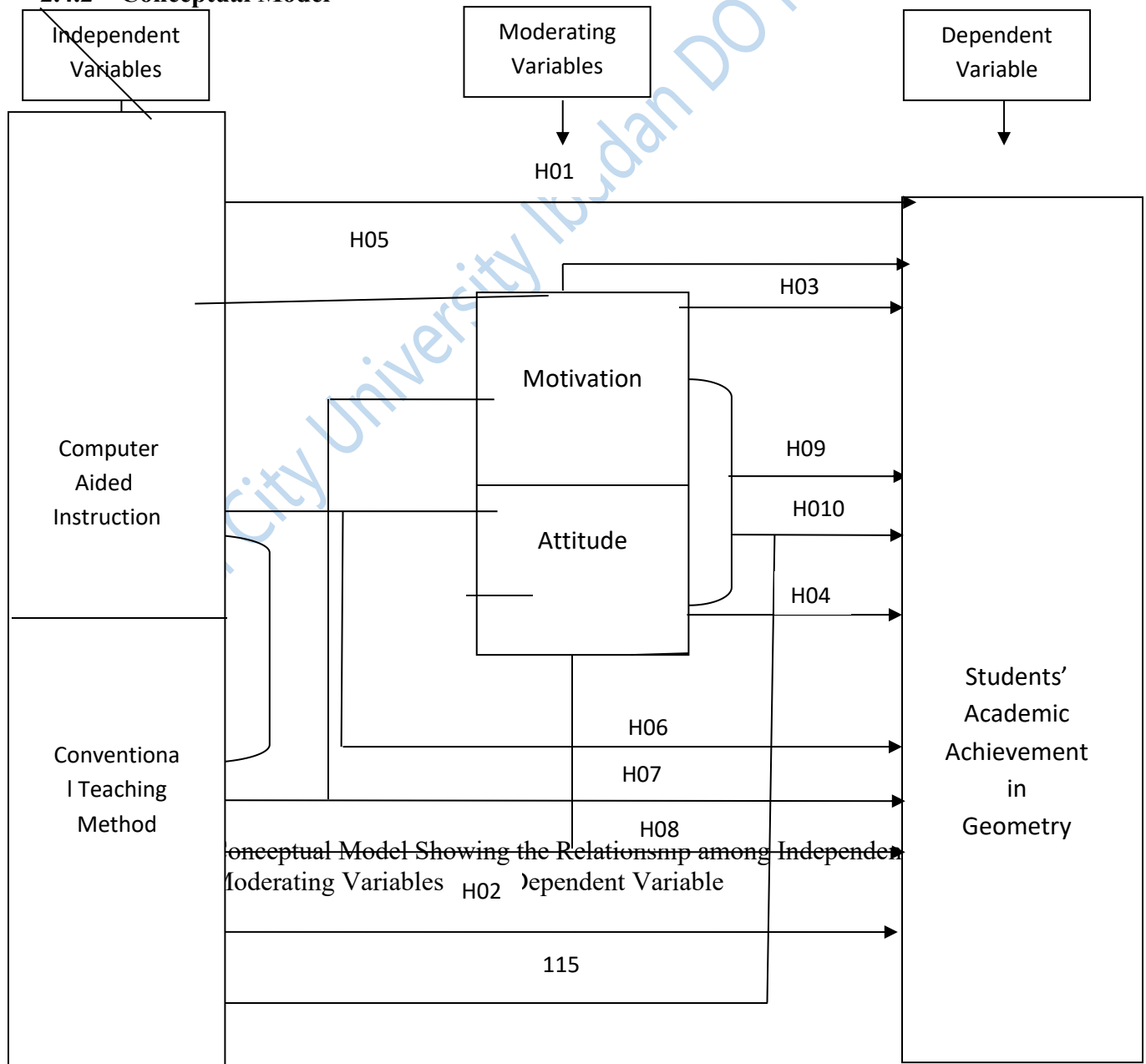
Mastering mathematics in elementary school is essential for students because it provides the foundation to learn the subject at the secondary school and university levels. A study aimed to examine the effect of implementing the Outdoor Learning in Mathematics (OLM) method to increase elementary students' motivation and learning achievements in geometry<sup>98</sup>. This study was carried out at one of the public elementary schools in Jember, East Java, Indonesia using an experimental research design. Participants were 54 grade 4 students consisting of class 4A and 4B, equally divided into the experimental and control groups, respectively. The experimental group was treated in the form of learning geometry topics using the OLM method, while the control group used conventional methods. Data were collected using questionnaires, observation, and tests. The obtained data were analysed using non-parametric statistics with SPSS software. The results showed that students' opinions were very positive.

Research findings in secondary schools have consistently indicated that geometry is one of the most difficult areas of Mathematics at basic level and students' attitude towards it has been a factor that is known to influence students' achievement in mathematics. The purpose of another study is to investigate the level of students' attitude towards geometry and to find out whether gender difference influences such attitude<sup>99</sup>. Some selected secondary schools in Zamfara state were used for the study. The study adopted a descriptive survey design using a questionnaire tagged Geometric Attitude Questionnaire. The population of the study consisted of SS I students in Zamfara state. A sample of 157 students was drawn using simple random sampling technique. Descriptive statistics of means and standard deviations were used to answer the research questions

while Inferential Statistics of the Mann-Whitney test was used to test the formulated hypothesis.

The study revealed that students' attitude towards geometry was relatively high generally, with male students having much higher positive attitude to geometry than their female counterparts and that difference between them was not statistically significant at  $\alpha = 0.05$  level of significance. It is recommended that teachers should be resourceful in encouraging and helping students in order to build positive attitude by trying to relate geometry to real life situations and also be gender sensitive.

### 2.4.2 Conceptual Model



**Source:** Field Work, 2024.

## **2.5 Summary of Gaps in Literature Reviewed**

Addressing these gaps in the literature would contribute significantly to a more comprehensive understanding of the effectiveness, challenges, and implications of employing Computer-Assisted Instruction in geometry for senior secondary school students specifically in Oluyole Local Government. There is a dearth of research focusing on the differential impact of CAI on various subgroups of senior secondary school students, including those with diverse learning abilities, socio-economic backgrounds, or special educational needs within Oluyole local government. Limited studies focus on the specific impact of CAI in geometry on senior secondary school students within Oluyole Local Government or similar regional contexts. Local factors, such as infrastructure, teaching methods, and student demographics, may influence the effectiveness of CAI, and these specific aspects need further exploration.

Also, many studies have primarily focused on short-term outcomes in terms of immediate academic performance. However, there's a lack of longitudinal studies that track the sustained impact of CAI in geometry on senior secondary school students' academic progress and success beyond immediate assessments, hence the need for this study. Another novelty about this study is that comparative research between the effectiveness of CAI in geometry and traditional teaching methods within Oluyole Local Government is relatively scarce. A comparative analysis could provide insights into the relative strengths and weaknesses of each method. Similarly, limited research emphasizes the role of teachers in facilitating and supporting CAI in geometry. Further investigation into the importance of teacher training, strategies for effective integration, and the impact

of teacher involvement on student outcomes is necessary. Thus, this study wants to shed light on it.

Another vocal point is Student Engagement and Interaction. More in-depth studies are needed to understand the level of student engagement, the nature of interactions, and the influence of individual learning styles within the context of CAI in geometry for SSS in Oluyole Local Government. Furthermore, another center of concentration of this is Technological Infrastructure and Accessibility. Few studies explore the influence of technological infrastructure, access to devices, internet connectivity, and software availability on the effectiveness of CAI in geometry specifically within the region of Oluyole Local Government.

Lead City University Ibadan DO NOT COPY

## Endnotes

1. P. C. Ukaigwe & K. E. Goi-tanen, *Effects of Computer Assisted Instruction On Mathematics Achievement among Secondary School Students In Rivers State, Nigeria*, **International Journal of Research and Innovation in Social Science**, 6, 2022, 341-347.
2. I. Lawal, *Effect of Computer-Aided Instruction on the Performance of Senior Secondary School Students in Geometry in Katsina, Katsina Sate, Nigeria*, **International Journal of Management, Social Sciences, Peace and Conflict Studies**, 3(2), 2020, 124-129.
3. X. Chen, C. K. Alan, W. F. Wilfred & E. S. Robert, *Effects Of Computer Assisted Instruction on Mathematics Achievement In Mainland China: A Meta-Analysis*, **International Journal of Educational Research**, 10(2), 2020, 102.
4. S. M. Adeniji, S. K. Ameen, B. U. Dambatta & Razak orilonise, *Effect of Mastery Learning Approach on Senior School Students' Academic Performance and Retention in Circle Geometry*, **International Journal of Instruction**, 11(4), 2018, 951-962.
5. B. Ö. Bülbül & M. Güler, *Can Geometry Achievement and Geometric Habits of Mind Be Improved Online? Reflections from a Computer-Aided Intervention*, **Journal of Educational Technology Systems**, 49(3), 2021, 376-398.
6. H. Serin, *The Impact of Technology-Aided Instruction on Motivation of Geometry Learners*, **International Journal of Social Sciences & Educational Studies**, 7 (3), 2020, 63-72.
7. D. Juandi, Y. Kusumah, M. Tamur, K. Perbowo, M. Siagian, R. Sulastri & H. Negara, *The Effectiveness of Dynamic Geometry Software Applications in Learning Mathematics: A Meta-Analysis Study*, **International Association of Online Engineering**, 10(2), 2021, 144-152.
8. D. Cichon & J. G. Ellis, *The Effects of Math Connections on Student Achievement, Confidence, and Perception Standards-based School Mathematics Curricula*, **Journal of Mathematics Education**, 2020, 345-374.
9. A. Moreno-Guerrero, M. R. Garcia, N. M. Heredia & A. Rodríguez-García, *Collaborative Learning based on Harry Potter for Learning Geometric Figures in the Subject of Mathematics*, **International Journal of Mathematics**, 8(3), 2020, 369.
10. O. Birgin & H. Acar, *The Effect of Computer-Supported Collaborative Learning using GeoGebra Software on 11th Grade Students' Mathematics Achievement in Exponential and Logarithmic Functions*, **International Journal of Mathematical Education in Science and Technology**, 53(4), 2022, 872-889.
11. C. Hayati & D. Serap, *The Effect of Technology Assisted Teaching on Success in Mathematics and Geometry: A Meta-Analysis*, **Journal of Educational Psychology**, 1(3), 2022, 358 - 397.

12. Y. Aiyim, K. Galiya, B. Ademi, M. Adilet, Z. Kamshat & K. Gulmira, *Development of the Logical Thinking of Future Mathematics Teachers through the use of Digital Educational Technologies*, **Cypriot Journal of Educational Sciences**, 17(6), 2022, 105-109.
13. Y. D. Arthur, *Mathematics Teachers' Acceptance of ICT in Teaching and Learning: An Extended Technology Acceptance Model*, **Problems of Education in the 21st Century**, 80(3), 2022, 408-425.
14. C. Constantinou, *Implications of Mathematics Standards on Geometry Education in New York States*, Teachers College, Columbia University Oroquest Dissertation & Theses, 2018. 10828601
15. S. Cementina, *Language Teachers' Digital Mindsets: Links between Everyday Use and Professional Use of Technology*, **TESL Canada Journal**, 36(3), 2019, 31-54.
16. B. Nwoke, *Enhancing Senior Secondary School Students' Performance in Geometry through Origami Instructional Approach*, **The International Journal for Technology in Mathematics Education**, 12(2), 2020, 56-67.
17. E. K. Suglo, C. S. Bornaa, A. B. Iddrisu & F. X. Adams, *Teachers' Geometry Vocabulary Competence and Students' Academic Performance in Circle Theorem*, **Journal of Education and Practice**, 14(19), 2023, 13-20.
18. B. Tamam & D. Dasari, *The use of Geogebra Software in Teaching Mathematics*, **Journal of Physics Conference Series**, **The 1st South East Asia Science, Technology, Engineering and Mathematics International Conference**, 1(8), 2020, 136.
19. S. T. Halime & A. Didem, *The Effects of Using Dynamic Geometry on Eighth Grade Students' Achievement and Attitude towards Triangles*, **The International Journal for Technology in Mathematics Education**, 23(3), 2016, 95.
20. D. P. Asuman & U. Behiye, *Effects of Drama-Based Geometry Instruction on Student Achievement, Attitudes, and Thinking Levels*, **The Journal of Educational Research** 102(4), 2009, 272-286.
21. O. Esra, *An Investigation on the Effects of Project-Based Learning on Students' Achievement in and Attitude towards Geometry*, Middle East Technical University, 2006
22. C. A. Tabuenal & J. Pentang, *Learning Motivation and Utilization of Virtual Media in Learning Mathematics*, **Asia-Africa Journal of Recent Scientific Research**, 1, 2021, 65-75.
23. T. O. Onansanya, G. A. Aladesusi, S. A. Taiwo, S. A. Onasanya, J. T. Adeoye, *Effect of Technology-Enabled Video Instruction on Senior Secondary School Students' Performance in Selected Technical Drawing Concept in Ilorin*, **Science & Technology**, 2(2) 2022, 122-131.

24. M. B. Ibáñez, A.U. Portillo, R.Z Cabada & M. L Barrón, *Impact of Augmented Reality Technology on Academic Achievement and Motivation of Students from Public and Private Mexican Schools: A Case Study In A Middle-School Geometry Course*, **Computers & Education**, 14(5), 2020, 103734.
25. Z. Hosseini, M. Mehdizadeh, Sadegi & Maryam, *Using GeoGebra in Teaching Geometry to Enhance Students Academic Achievement and Motivation*, **Innovare Journal of Education**, 10(3), 2022, 34-38.
26. J.Y. Mensah & M. J. Nabie, *The Effect of PowerPoint Instruction on High School Students' Achievement and Motivation to Learn Geometry*, **International Journal of Technology in Education**, 4(3), 2021, 331-350.
27. J. Y. Mensah, *Effect of ICT Integration on Senior High Students' Motivation and Achievement in Geometry, the Case of Gomoa West District*, A Dissertation in the Department of Mathematics Education, in the University of Education, Winneba, 2019.
28. N. Süren & M. A. Kandemir, *The Effects of Mathematics Anxiety And Motivation on Students' Mathematics Achievement*, **International Journal of Education in Mathematics, Science and Technology**, 8(3), 2020, 190-218,
29. H. Serin, *The Impact of Technology-Aided Instruction on Motivation of Geometry Learners*. **International Journal of Social Sciences & Educational Studies**, 7(3), 2020, 63-72.
30. A. Alfauzan, A. Alimni, A. K.Dwi, T.Elza & A. P. Wahyu, *Implications of Teacher Interpersonal Communication Ability on Student Learning Motivation in Islamic Religious Education Lessons During Pandemic*, **Journal of Education Research and Evaluation**, 6(1), 2022, 156-167.
31. S. Sudirman, M. Mellawaty, Y. Poppy & I. Rully, *Integrating Local Wisdom Forms in Augmented Reality Application: Impact Attitudes, Motivations and Understanding of Geometry of Pre-Service Mathematics Teachers*, **International Association of Online Engineering**, 10(2), 2020, 134-145.
32. A. Hidayatullah & C. Csíkos, *The Role of Students' Beliefs, Parents' Educational Level, and The Mediating Role of Attitude and Motivation in Students' Mathematics Achievement*, **The Asia-Pacific Education Researcher**, 33(2), 2024, 253-262.
33. S. T. Halime & A. Didem, *An Investigation on the Effect of STEM Practices on Sixth Grade Students' Academic Achievement, Problem Solving Skills, and Attitudes towards STEM*, **The International Journal for Technology in Mathematics Education**, 23(3), 2016, 95.

34. O. N.Cecilia, E. O.Richard, A. N.Hope, O. U.John, E. U.Uduak & Mary A. I., *Students' Attitude and Academic Achievement in a Flipped Classroom*, **Journal of Science Learning**, 8(1), 2022, 134.
35. H. Sunghwan & S. Taekwon, *Students' Attitude toward Mathematics and its Relationship with Mathematics Achievement*, **Journal of Education and e-Learning Research**, 8(3), 2021, 272-280.
36. O Birgin & F Topuz, *Effect of the Geogebra Software-Supported Collaborative Learning Environment on Seventh Grade Students' Geometry Achievement, Retention and Attitudes*, **The Journal of Educational Research**, 12(2), 2021, 474-494.
37. S. John, A. Paul & K. Slava, *Cognitive Load Theory*, Springer, 2011
38. L. Stephen, *Applying Cognitive Learning Theory to Adult Learning*, Informtion Age Publishing, 1991
39. P. Fred, R. Alexander & S. John, *Cognitive Load Theory and the Format of Instruction*, **Cognition and Instruction Journal**, 5(7), 2003.
40. L. P. Jan, M. Roxana & B. Roland, *Cognitive Load Theory and Instructional Design: Recent Developments*, **Educational Psychologist**, 2010.
41. C. C. Ruth & E. M. Richard, *Cognitive Load Theory: Instructional Implications for the Design of Multimedia*, **Journal of Educational Psychology**, 5(7), 2021.
42. T. F. Catherine & S. P. Randall, *Constructivism: Theory, Perspectives, and Practice*, Teachers College Press, 2005.
43. T. F.Catherine& H. Carollee, *Constructivist Learning Design: Key Questions for Teaching to Standards*, Teachers College Press, 2005.
44. P. S. Leslie, *Constructivism in Education*, Lawrence Erlbaum Associates, 1995
45. L. Marie, B. Nadine & G. James *Constructivism: Its Foundations and Applications*, Lawrence Erlbaum Assoc iates, 1998
46. S.Arik & M. Yilmaz, *The effect of Construtivist Learning Approach and Active Learning on Environmental Education: A Meta Analysis Study*, **International Journal of Science Education and Environmental**, 3(1), 2020, 456.
47. Y. S. Kusumah, D. Kustiawati & T. Hermarn, *The Effect of GeoGebra in Three-Dimensional Geometry Learning on Students' Mathematical Communication Ability*, **International Journal of Instruction**, 13 (2), 2020, 895-908.

48. S. K. Ekundayo, *Effects Of Computer-Assisted Instruction (CAI) on Students Academic Achievement in Chemistry among Boys and Girls in Public Secondary Schools in Ondo State, Nigeria*, **British Journal of Education**, 10(2), 2022, 31-41. Available online: Doi: <https://doi.org/10.37745/Bje.2013>
49. S. Egarievwe, A. O. Ajiboye & G. Biswas, *Internet Application of Lab VIEW in Computer Based Learning*, **Journal of Science Learning**, 2(1), 2000, 121-130.
50. J. Mohammed, O. Onasanya & S. Adenubi, *Exploring The Effectiveness Of E – Learning: A Scoping Review Of Qualitative And Quantitative Research*, **ejournal.Upi.Edu Mimbar Pendidikan**, (2), 2023, 101-108.
51. V. Lev, *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, 1978.
52. R. Barbara & M. Jayanthi, *Guided Participation in Cultural Activity by Toddlers and Caregivers*, Cambridge University Press, 1990
53. R. Barbara, *The Zone of Proximal Development: Where Culture and Cognition Create Each Other*, The Sage Handbook of Cultural Analysis, 2008
54. K. Olga & K. Igor, *Zone of Proximal Development (ZPD): A Conceptual Tool for Building the Learning Process*, **Social and Behavioral Sciences**, 7(8), 2021, 87-94.
55. B. Albert, *Social Learning Theory*, Prentice Hall, 1977
56. E. M. Neal & D. John, *Social Learning and Imitation*, Yale University Press, 1941
57. B. Albert, *Social Learning Theory of Aggression*, Communication Review, 1978
58. S. Fatimah & D. N. Rosidin, *Student-based Learning in the Perspective of Constructivism: Theory and Maieutics Method*, **International Journal of Science Education**, 3(4), 2020, em74123.
59. B. Albert, *Modeling Processes in Social Learning*, Advances in Experimental Social Psychology, 1965
60. L. B. Robert & L. A. Ronald, *Social Learning Theory and the Process of Imitation*, American Sociological Review, 1966
61. D. D. Fred, P. B. Richard & R. W. Paul, *User Acceptance of Computer Technology: A Comparison of Two Theoretical Models*, **Journal of Management Science**, 6(3), 2022
62. V. Viswanath & D. D. Fred, *Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior*, **Information Systems Research**, 6(9), 2020, 47-54.

63. V. Viswanath, *The Role of Perceived Usefulness, Perceived Ease of Use, and Social Influence in the User Acceptance of Information Technology*, MIS Quarterly, 2003
64. G. Shirley & J. David, *Information Systems Research: Relevant Theory and Informed Practice*, Routledge, 2007
65. B. Urie, *Ecological Systems Theory*, Harvard University Press, 1979
66. B. Urie & A. M. Pamela, *Making Human Beings Human: Bio Ecological Perspectives on Human Development*, SAGE Publications, 2006
67. B. Urie, *Ecological Systems Theory, Readings on the Development of Children*, Worth Publishers, 2002
68. B. Urie, *The Ecology of Human Development: Experiments by Nature and Design*, Harvard University Press, 1979.
69. A. M. Mark & E. M. Jessica, *Ecological Systems Theory in Education Research: Conceptual Underpinnings and Practical*, **Educational Researcher**, 7(1), 2008
70. J. G. Ruud, *Ecological Systems Theory: A Valuable Framework for Research on Inclusion and Special Educational Needs*, **European Journal of Special Needs Education**, 6(1), 2004, 136.
71. Y. Maha & A. Z. Nadera, *Ecological Systems Theory: A Strengths-Based Approach for Understanding and Addressing Child Behavioral Problems*, **International Journal of Higher Education**, 10(2), 2020, 22-29.
72. C.Huaruo, W. Ya & J. Jiuren, *Computer Teaching And Learning Of Basic Elementary Functions*, **Heliyon Journal**, 6(7), 2023, 57-58.
73. Alghadari, F. T. Herman & S. Prabawanto. Factors Affecting Senior High School Students to Solve Three-Dimensional Geometry Problems, **International Electronic Journal of Mathematics Education**, 15(3), 2020, 590
74. D. Juandi, Y.S. Kusumah, M.Tamur, K. S. Perbowo & T. T. Wijaya, *A Meta-Analysis of Geogebra Software Decade of Assisted Mathematics Learning: What to Learn and Where To Go?*, **A Research Article**, 7(5), 2021
75. M. S. Uwurukundo, J. F. Maniraho & M. T. Rwibasira, *Effect of Geogebra Software on Secondary School Students' Achievement in 3-D Geometry*, **Education and Information Technologies**, 27(4), 2022, 5749-5765.
76. H. Zulnaidi, E. Oktavika & R. Hidayat, *Effect Of Use Of Geogebra on Achievement of High School Mathematics Students*, **Education and Information Technologies**, 25(1), 2022, 51-72.

77. W. Y. Abera & G. A. Zergaw, *Some of the Potential Affordances, Challenges and Limitations of Using GeoGebra in Mathematics Education*, **Eurasia Journal of Mathematics, Science and Technology Education**, 15(8), 2019, 1734.
78. H. Ramatu, *Effects Of Computer -Assisted Instruction on Achievement of Junior Secondary School Students in Social Studies in Niger State, Nigeria*, **Journal of Science Learning**, 8(2), 2022, 136.
79. H. Ramatu, *Effects Of Computer – Assisted Instruction on Varied Ability groups Among Junior Secondary School Students In Social Studies in Niger State, Nigeria*, **Journal of Science Learning**, 7(1), 2020, 128.
80. A. G. Jamilu, *Effect Of Computer-Assisted Instruction on Students’ Academic Performance and Retention in Chemistry Concepts*, **Journal of Science, Technology, Mathematics Pedagogy**, 2(1), 2024, 1-12
81. V. S.Ilyos Abdullayev, H. Hajiyev, M. Y. A.Kozachek & R. Zakieva. *Blended Learning: The Effect on Students’ Self-Regulation and Academic Achievements*, **Journal of Science Learning**, 9(1), 2024, 101-112.
82. A. R. Bayanova, N. A. Orekhovskaya, N. L. Sokolova, E. F. Shaleeva, S. A. Knyazeva & R. L. Budkevich , *Exploring The Role Of Motivation In Stem Education: A Systematic Review*, **Eurasia Journal Of Mathematics, Science And Technology Education**, 18(4), 2022, em2250. Available online: <https://doi.org/10.29333/ejmste/13086>
83. A. A. Arigbabu, O. W. Lawal, A. R. Hassan, T. O. Abiodun & S. O. Ganiyu, *Perception Of Teachers And Students On The Use Of Mobile Applications In Teaching And Learning Of Mathematics*, Department Of Mathematics, Tai Solarin University Of Education Ijagun, Ogun State, Nigeria, 2021.
84. O. Owede & K. Eli, *Use Of Computer Aided Instructions (CAI) at Secondary School on Academic Performance of Undergraduates in Bayelsa State*, **Journal Of Educational Research**, 10, 2024, 124.
85. H. M.Muftawu & A. A. Benard, *Effects Of Computer Assisted Instruction on Learning Outcome in Science Subjects among Secondary School Students in Kogi State, Nigeria*, **Custech International Journal Of Economics**, 7, 2024, 17-34.
86. L. J. D. Rosali, *Effect of Computer-Assisted Instruction (CAI) on the Academic Achievement in Secondary Physics*, **Open Access Library Journal**, 7, 2020, e6319. Available online: <https://Doi.Org/10.4236/Oalib.1106319>.
87. M. O. Nkiko, *Interrogating The Teaching and Learning of Chemistry in Nigerian Private Universities: Matters Arising*, **Journal Of Education And Learning**; 10(3), 2021, 13-23.

88. P. K. Alheri, U. Burgasa, A. Isah & Y. Gambo, *Motivation and Academic Achievement of Students toward Sustainable National Development in Nigeria: A Pragmatic Approach*, **African Journal of Humanities and Contemporary Education Research**, 6(1), 2022, 69-79.
89. P. Mao, Z. Cal, J. He, X. Chen & X. Fan, *The Relationship Between Attitude toward Science and Academic Achievement in Science: A Three -Level Meta-Analysis*, **Frontiers In psychology**, 12, 2021, 784068.
90. E. U. Akuche & S. O. Adeniyi, *Factors influencing the enrolment of students for science subjects among secondary schools in Oluyole Local Government Area, Ibadan*, **IFE PsychologIA: An International Journal**, 25(1), 2017, 444-462.
91. A. B. Adeniyi & A. M. Mojirade, *Students Perception Towards the Use of ICT in Teaching and Learning of Social Studies in Oluyole Local Government Area, Oyo State*, **IFE PsychologIA: An International Journal**, 30(2), 2022, 1-10.
92. M. D. Oyetade, M. Beckley & A. O. Oredein, *Peer Group Influence as a Correlate of Secondary School Students' Motivation towards Learning in Oluyole Local Government, Ibadan* **Journal of Capital Development in Behavioural Sciences**, 8(2), 2020, 60-73.
93. 94 S. Sudirman, M. Mellawaty, P. Yaniawati & R. Indrawan, *Integrating Local Wisdom Forms in Augmented Reality Application: Impact Attitudes, Motivations and Understanding of Geometry of Pre-service Mathematics Teachers*, **International Association of Online Engineering**, 7(17), 2020, 217-224. Available online: <https://www.learntechlib.org/p/217753/>.
94. P. Sarkar, K. Kadam & J. S. Pillai, *Learners' Approaches, Motivation and Patterns of Problem-Solving on Lines And Angles in Geometry Using Augmented Reality*, **International Association of Online Engineering**, 7(17), 2020, 172-181.
95. A. S. Salifu, M. J. Nabie & J. Apawu, *College Of Education Pre-Service Teachers' Attitude in Terms of Usefulness, Confidence and Enjoyment Towards Geometry by Gender*, **Contemporary Mathematics and Science Education**, 2(2), 2021, ep21012.
96. M. S. Uwurukundo, J. F. Maniraho, M. Tusiime, I. Ndayambaje & V. Mutarutinya, *Geogebra Software in Teaching and Learning Geometry of 3-Dimension to Improve Students' Performance and Attitude of Secondary School Teachers and Students*, **Education and Information Technologies**, 29(8), 2024, 10201-10223.
97. D. S. Pambudi, *The Effect of Outdoor Learning Method on Elementary Students' Motivation and Achievement in Geometry*, **International Journal of Instruction**, 15(1), 2022, 747-764.

98. B. Suleiman, A. Isma'il,& A. Bello, *Investigation into Secondary School Students' Attitude towards Learning of Geometry in Zamfara State, Nigeria*, **IRA International Journal of Education and Multidisciplinary Studies**, 16(4), 2020, 236-242.

Lead City University Ibadan DO NOT COPY

## Chapter Three

### Methodology

This chapter discussed the methodology for the study under the following headings:

#### 3.1 Research Design

The research design for this study is a 2x2x1 factorial matrix quasi-experimental design of pre-test-post-test non-randomized and non-equivalent experimental control groups. It focuses on treatment at two (2) levels (computer aided instruction and control group), moderating variable at two levels (students' motivation and attitude) and dependent variable at one level (academic achievement in geometry). Computer aided instruction is independent variable which serves as the treatments for the experimental groups, while the conventional teaching method is used for the control group. Students' achievement in Geometry Achievement Test (GAT) at the pre-test and post-test levels will be the dependent variable while students' motivation and attitude will serve as moderating variables.

**Table 3.1 Schemata Representation**

Group	Pretest	Treatment	Post Test
C A I group 1	O <sub>1</sub>	X <sub>1</sub>	O <sub>2</sub>
C A I group 2	O <sub>3</sub>	X <sub>2</sub>	O <sub>4</sub>
Control group 1	O <sub>5</sub>	X <sub>3</sub>	O <sub>6</sub>

**Source:** Reseracher's Fieldwork, 2024

Where

O<sub>1</sub>= Pretest scores experimental group 1

O<sub>3</sub>= Pretest scores of experimental group 2

$O_5$ = Pretest scores of control group

$O_2$ =Posttest scores of experimental group 1

$O_4$ = Posttest scores of experimental group 2

$O_6$ = Posttest scores of control group

$X_1$ = Experimental group 1 (CAI)

$X_2$ = Experimental group 2 (CAI)

$X_3$ = Control group (Conventional)

### **3.2 Population of the study**

The population of the study comprised of all senior secondary school two students enrolled in government owned schools within Oluyole Local Government who are offering mathematics constitute which is five thousand three hundred and thirty nine (5,339) students in twenty seven government secondary schools.

### **3.3 Sample Size and Sampling Techniques**

Purposive sampling technique will be used to select schools from the targeted population using these criteria. (1). Schools that are government owned (2). Schools that have at least one (1) qualified Mathematics teacher for SS11 (3) Schools that have Mathematics teachers with at least seven (7) years of experience of being Examiner to external examination bodies (4) Schools that have standard Computer laboratory. Four (4) public co-educational secondary schools will be purposively selected in Oluyole local government areas. Selected schools are Abe Technical Secondary school with 245 as the number of students in SSSII, Community Grammar School, Ayegun with 424 as the

number of students in SSSII, Christ High school, Oleyo with 325 as the number of students in SSSII and Methodist High School, Express way with 49 as the number of students in SSS II. Intact senior secondary school II class will be used in each school for the experiment.

### **3.4. Description of the Research Instrument**

The researcher assesses the students' understanding of geometry concepts before and after the intervention using:

- Geometry Achievement Test (GAT),
- Lesson plan for CAI,
- Lesson plan for control group,
- Students' Motivation Questionnaire (SMQ).
- Students' Attitude Questionnaire (SAQ).

#### **Geometry Achievement Test (GAT)**

A GAT is a specialized assessment designed to measure the academic achievement of senior secondary school two students in mathematics geometry, particularly focusing on the effect of CAI on their learning outcomes. This test evaluates students' understanding and application of geometric concepts such as lines, angles, shapes, properties, and theorems.

The GAT aims to assess the students' proficiency in geometry before and after receiving instruction through computer-assisted learning tools. The test typically includes a variety of question types such as multiple-choice, true/false, short answer, and problem-solving tasks to comprehensively evaluate students' knowledge, critical thinking, and

analytical skills in geometry. The table of specification for the items in which Knowledge with 25%, Comprehension with 30% and Application 45% are shown below:

**Table 3.4.1: of Specification for Students Geometry Achievement Test**

Topic S/N	Geometry	Level of Cognition			Total
		Knowledge 25%	Comprehension 30%	Application 45%	
1	Chords and	2	2	2	6
2	Arcs				
3	Angles in a Circle	1	3	2	6
4	Cyclic Quadrilateral	2	2	2	6
	Bisector of Angle in a Triangle	1	4	2	7
<b>Total</b>		<b>6</b>	<b>11</b>	<b>8</b>	<b>25</b>

**Source:** Reseracher's Fieldwork, 2024

As it was shown in the table above, the level of knowledge, comprehension and application were tested under the four enlisted sub topics in the table. In the table only 10 out of 40 items were tested on knowledge with 25% (i.e number of items divided by the total number of questions multiplied by 100). Also, 11 out of 40 items were tested on comprehension with 30% (i.e number of items divided by the total number of questions multiplies by 100). 19 out of 40 were tested on Application with 45% (i.e number of items divided by the total number of questions multiplied by 100).

### **Lesson Plan for Computer Assisted Instruction (CAI)**

A lesson plan for CAI on the academic achievement of SSS two students in geometry in Oluyole Local Government using laptop, Projector and screen for demonstrations. The research assistants will teach with the aid of computer aided tools that are available in schools as a treatment to support learning. The research assistants

will write lesson notes and project the work with a laptop in which geogebra software application has been installed on the screen for demonstration. This will help in improving students' understanding of geometric concepts such as angles, lines, and shapes and develop students' problem-solving skills in geometry through interactive computer-based learning.

### **Lesson Plan for Control Group**

In conducting a study on the effect of CAI on the academic achievement of senior secondary school two students in mathematics geometry in Oluyole Local Government, it is essential to have a control group that does not receive CAI. The research assistants will teach without any instructional materials. The research assistants will rely on the use of a chalkboard for instruction, the research assistants will be more active and the students are passive. The research assistants will write the lesson note. The lesson plan for the control group is similar to the CAI group in terms of content and objectives, but without the use of computer-assisted tools.

### **Students' Attitude Questionnaire (SAQ) and Students' Motivation Questionnaire (SMQ)**

Student's attitude and student's motivation questionnaire are valuable tools for assessing senior secondary school two students' opinions and feelings about their experience with CAI in mathematics geometry in Oluyole Local Government. The questionnaire will provide insights into students' preferences, challenges, and perceived benefits of using CAI in their learning process.

### 3.5 Validity of the Research Instrument

The research instrument was validated by the researcher's supervisor and two (2) experts at the Department of Science Education, Lead City University, Ibadan, Nigeria. All corrections and modifications were effected before being used to assess academic achievement of the senior secondary school students in geometry.

### 3.6 Reliability of The Research Instrument

Kuder Richardson-20 (KR-20) was used to calculate the reliability value of the instrument (GAT) by administering the instrument on another set of participants from another school apart from the selected schools but share the same properties. The reliability value of the instrument (GAT) is 0.81

**Geometry Achievement Test (GAT):** This was given to the researcher supervisor Lead City University, Ibadan to check the content of the instruments if it is relevant to the senior secondary school two mathematics curriculums and to make the necessary corrections to suit the purpose of the study before use. The validators also checked the geometry lesson plans to whether they covered the activities involved in the teaching and learning strategies to be used in the study.

**Lesson Plan for CAI:** Notes were given to the researcher's supervisor, experts in the Department of Science Education, Lead City University, Ibadan, to look at the content, construct and face validity of the instruments.

**Lesson Plan for Control Group:** Notes were given to the researcher's supervisor, experts in the Department of Science Education, Lead City University, Ibadan, to look at the content, construct and face validity of the instruments.

**Students' attitude and students' motivation Questionnaire:** These were given to the researcher's supervisor, experts in the Department of Science Education, Lead City University, Ibadan, to look at the content, construct and face validity of the instruments.

### 3.7. Method of Data Administration

Data were collected using the following procedural steps: selection and training of research assistants, administration of the pretest, treatment, and administration of post-test. The number of weeks scheduled for data collection is summarized below:

Selection and training of research assistants	1 weeks
Pretest administration	1 week
CAI Intervention	4 weeks
Revision	1 week
Post-test administration	1 week
<b>Total</b>	<b>8 weeks</b>

### 3.8 Data analysis

The information gathered will be examined using frequency counts and standard deviation while the hypotheses for the study will be tested using ANCOVA at 0.05 level of significance.

### **3.9 Ethical Approval**

Ethical approval is crucial as it ensures that research involving participant is conducted ethically, respecting their rights, dignity, and safety. Approval from the Honourable Commissioner, Ministry of Education Science and Technology, Oyo State to carry out research in Oluyole Local Government was gotten. Also, approval from the principals of the school involved are sorted that the proposed study will meet ethical standard and safeguards the welfare of the participants. The researcher ensures the confidentiality, privacy, and anonymity of participants and their data throughout the study.

### Endnotes

1. Y. D. Arthur, *Mathematics Teachers' Acceptance of Ict in Teaching and Learning: An Extended Technology Acceptance Model*, **Problems of Education in the 21st Century**, 80(3), 2022, 408-425. Available online: doi:10.33225/pec/22.80.408
2. P. Boyd & A. Ash, *Mastery Mathematics: Changing Teacher Beliefs around In-Class Grouping and Mindset*, **Teaching and Teacher Education**, 75, 2018, 214-223. Available online: doi:10.1016/j.tate.2018.06.016
3. C. Constantinou, *Implications of Mathematics Standards on Geometry Education in New York States*, Teachers College, Columbia University Oroquest Dissertation & Theses, 2018, 10828601.
4. S. Chand, K. Chaudhary, A. Prasad & V. Chand, *Perceived Causes of Students' Poor Performance in Mathematics: A Case Study at Ba and Tavua Secondary Schools*, **Frontiers in Applied Mathematics and Statistics**, 7, 2021, Available online: doi:10.3389/fams.2021.614408

## Chapter Four

### Results and Discussion of Findings

The results and discussion of findings of the investigation are presented in this chapter. The findings were based on the hypotheses that were raised in accordance with the study's objective.

#### 4.1 Presentation of Data

**Table 4.1 Demographic Data**

Variable	Frequency	Percentage
Gender		
Male	73	48.7%
Female	77	51.3%
<b>Total</b>	<b>150</b>	<b>100.0%</b>

**Source:** Field Survey Report, 2024

Table 4.1 presents the distribution of participants based on gender. Out of the total participants, 73 (48.7%) identified as male, while 77 (51.3%) identified as female. This shows a relatively balanced representation of both genders in the study.

**Table 4.2 Descriptive Statistics of the Dependent Variable – Students Performance in Geometry**

	<b>Pretest</b>	<b>Posttest</b>
N	150	150
Missing	0	0
Mean	33.93	54.95
Median	34.00	56.00
Standard deviation	11.92	17.19
Minimum	10.00	12.00
Maximum	69.00	89.00

**Source:** Field Survey Report, 2024

Table 4.2 provides descriptive statistics for the dependent variable, students' academic performance in Geometry as measured by the GAT. For pretest, the sample size (N) is 150, indicating the number of learners that took part in the pretest. There are no missing values, meaning that all participants had scores for the pretest. The mean value of the pretest is 33.93, indicating that, on average, the pretest in the sample scored relatively below the average which is 50.00. The median value is 34.00, which suggests that the distribution of responses is slightly skewed towards lower performance. The standard deviation is 11.92, which implies that there is a moderate amount of variability in the pretest scores. Furthermore, the least and the maximum scores are 10 and 69 respectively. Similarly, for posttest, the sample size is also 150, and there are no missing values. The mean value for posttest is 54.95, indicating a relatively high average score. The median value of 56.00 suggests that the distribution of responses is slightly skewed towards higher performance score. The standard deviation is 17.19, indicating a moderate amount

of variability in the responses for the posttest score. While the least and the maximum scores are 12 and 89 respectively. This implies there is an improvement in the performance of students after the intervention (use of new teaching strategies) but the magnitude of the improvement will be determined with the below Analysis of Covariance (ANCOVA).

**Table 4.3 Descriptive Statistics of the Independent Variables as measured by Students' Motivation Questionnaire (SMQ) and Students' Attitude Questionnaire (SAQ)**

	Students' Motivation	Students' Attitude
N	150	150
Missing	0	0
Mean	2.92	2.86
Median	2.83	2.50
Standard deviation	0.14	0.12
Minimum	1.00	1.00
Maximum	5.00	5.00

**Source:** Field Survey Report, 2024

Table 4.3 provides descriptive statistics for the variables related to the students' motivation and attitude as measured by the SMQ and SAQ. For Students' Motivation, the sample size (N) is 150, indicating the number of valid responses received for this variable. There are no missing values, meaning that all participants responded to the questionnaire and provided data for Students' Motivation. The mean value of Students' Motivation is 2.92, indicating that, on average, students scored relatively low on Students' Motivation.

The median value is 2.83, which suggests that the distribution of responses is slightly skewed towards lower motivational ratings. The standard deviation is 0.14, which implies that there is a moderate amount of variability in the responses for Students' Motivation. Similarly, for Operational Performance, the sample size is also 150, and there are no missing values. The mean value for students' attitude is 2.95, indicating a relatively low average rating. The median value of 2.64 suggests that the distribution of responses is slightly skewed towards low attitudinal ratings. The standard deviation is 0.15, indicating a moderate amount of variability in the responses for students' attitude.

**Table 4.4 Descriptive Statistics of students' performance in geometry based on students Motivation and Students' Attitude**

Performance in Geometric Test	Students' Motivation		Student's Attitude	
	High	Low	Positive	Negative
Mean score	63.19	33.26	59.36	37.18

**Source:** Field Survey Report, 2024

Table 4.4 above descriptively shows the mean values of students as they responded to the motivation and attitude questionnaires. Students' motivation toward the computer assisted instruction was classified as high and low. The means value is 36.19 and 33.26 respectively. This implies that students with high motivation towards CAI scored above average while their counterpart with low motivation score below average. In the same vein, students with positive attitude towards CAI performed better (59.26) than their counterparts who developed negative attitude toward the method.

**Table 4.5: Summary of ANCOVA on the Post-test Achievement Scores in Geometry According to Teaching Strategies and Motivation and Attitude**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
<b>Main Effects</b>						
Corrected Model	13449.245 <sup>a</sup>	4	3362.311	15.940	.000	.305
Intercept	454793.999	1	454793.999	2156.033	.000	.937
CAI	11512.776	1	11512.776	54.578	.000	.273
Conventional	328.166	1	328.166	1.556	.214	.011
Motivation	1177.549	1	1177.549	5.582	.019	.037
Attitude	1311.200	1	1311.200	6.216	.014	.041
Error	30586.329	145	210.940			
Total	496906.000	150				
Corrected Total	44035.573	149				

a. R Squared = .605 (Adjusted R Squared = .586)

Source: Field Survey Report, 2024

## 4.2 Answering of Research Hypotheses

Findings from the study are presented below following the hypotheses tested.

**H<sub>01</sub>:** There will be no significant main effect of CAI on Senior Secondary School students' academic achievement in geometry.

Table 4.5 shows that there was a significant main effect of CAI on Senior Secondary School students' academic achievement in geometry. [ $F_{(1, 145)} = 54.578$ ;  $P < .05$ ]. Hence the  $H_0$  is rejected. This implies that there is significant difference in the pretest and posttest scores of students taught with CAI. Furthermore, the partial eta square (.273) shows that CAI contributes 27% of variation in the students' academic performance in geometry.

**H<sub>02</sub>:** There will be no significant main effect of conventional method on Senior Secondary School students' academic achievement in geometry.

There was no significant main effect of conventional teaching methods on the academic achievement of senior secondary school students in geometry [ $F_{(1,145)} = 1.556$ ;  $P > .05$ ]. Since  $P > .05$ , the  $H_0$  is therefore not rejected. The value of eta square, .011 implies that conventional teaching strategies contributes just 1% of the variation in the students' academic performance in geometry. This implies that the conventional method was not effective in teaching geometry among SS2 Students in Oluyole Local Government Area, Ibadan.

**H<sub>03</sub>:** There will be no significant main effect of motivation on SSS students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

The result from table 4.5 above revealed that there was significant effect of students' motivation on the academic achievement of senior secondary school students in Geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,145)} = 5.582$ ;  $P < .05$ ], the  $H_0$  is therefore rejected. This implies that the motivation of students towards the Computer Assisted Instructions contribute significantly to their academic achievement in geometry. The value of Eta Square .037 signifies that motivation contributes 4% of the variation in the students' academic performance in geometry.

**H<sub>04</sub>:** There will be no significant main effect of attitude on SSS students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

As depicted in the table 4.5 above, there was significant main effects of student's attitude towards CAI on academic achievement of SSS in geometry in Oluyole Local

Government Area, Ibadan. [ $F_{(1,145)} = 6.216$ ;  $P < .05$ ], the  $H_0$  is therefore rejected. The value of eta square, .041 implies that attitude contributes 4% the variation in the students' academic performance in geometry.

**Table 4.6: Summary of 2-Ways ANCOVA on the Post-test Achievement Scores in Geometry According to Teaching Strategies and Motivation and Attitude**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
<b>2- Ways Interactive Effects</b>					
Corrected Model	18076.955 <sup>a</sup>	10	1807.696	9.680	.000
Intercept	387178.167	1	387178.167	2073.214	.000
CAI * Attitude	424.289	1	424.289	3.272	.034
Conventional * Attitude	1346.290	1	1346.290	7.209	.008
Motivation * Attitude	686.752	1	686.752	2.677	.051
CAI * Conventional	43.551	1	43.551	3.233	.030
CAI * Motivation	1865.024	1	1865.024	9.987	.002
Conventional * Motivation	1862.589	1	1862.589	9.974	.002
Error	25958.618	139	186.753		
Total	496906.000	150			
Corrected Total	44035.573	149			

a. R Squared = .411 (Adjusted R Squared = .368)

Source: Field Survey Report, 2024

**H<sub>05</sub>:** There will be no significant interaction effect of CAI and motivation on SSS students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

Result from table 4.6 above shows that there was significant interaction effect of CAI and students' motivation on academic achievement of senior secondary students in

geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,139)} = 9.987$ ;  $P < .05$ ], the  $H_0$  is therefore rejected. This implies that when computer assisted instructions are combined with students' motivation (positive or negative) contributes to the students' performance in geometry.

**H<sub>06</sub>:** There will be no significant interaction effect of CAI and attitude on SSS students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

The result from table 4.6 shows that there is significant interaction effects of CAI and attitude on academic achievement of SSS in geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,139)} = 3.272$ ;  $P < .05$ ], the  $H_0$  is therefore rejected. This implies that Computer Aided Instruction (CAI) and with positive attitude will enhance students' academic achievement in geometry and vice versa.

**H<sub>07</sub>:** There will be no significant interaction effect of conventional method and motivation on SSS students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

As shown in table 4.6 above, there was significant interaction effects of conventional method and motivation on academic achievement of SSS in geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,139)} = 9.974$ ;  $P < .05$ ], hence, the  $H_0$  is rejected.

**H<sub>08</sub>:** There will be no significant interaction effect of conventional method and attitude on Senior Secondary School students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

From table 4.6 above, there was no significant interaction effects of conventional method and attitude on academic achievement of senior secondary students in geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,139)} = 7.209$ ;  $P < .05$ ], hence, the  $H_0$  is rejected.

**H<sub>09</sub>:** There will be no significant interaction effect of motivation and attitude on Senior Secondary School students' academic achievement in geometry in Oluyole Local Government Area, Ibadan.

From table 4.6 above, there was significant interaction effect of motivation and attitude on Senior Secondary School students' academic achievement in geometry in Oluyole Local Government Area, Ibadan. [ $F_{(1,139)} = 2.677$ ;  $P < .05$ ], hence, the  $H_0$  is rejected.

**Table 4.7: Summary of 3-ways interactions ANCOVA on the Post-test Achievement Scores in Geometry According to Teaching Strategies and Motivation and Attitude**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
<b>3-ways Interactive Effect</b>					
Corrected Model	18202.011 <sup>a</sup>	14	1300.144	6.794	.000
Intercept	79922.162	1	79922.162	1985.382	.000
CAI * Conventional * Attitude	45.557	1	45.557	10.238	.001
CAI * Motivation * Attitude	15.701	1	15.701	12.082	.000
Conventional * Motivation * Attitude	11.115	1	11.115	8.058	.012
CAI * Conventional * Motivation	86.459	1	86.459	6.452	.043
Error	25833.562	135	191.360		
Total	496906.000	150			
Corrected Total	44035.573	149			

a. R Squared = .413 (Adjusted R Squared = .353)

Source: Field Survey Report, 2024

**H<sub>0</sub>10:** There will be no significant main interaction effect of conventional method, motivation and attitude on SSS students' academic achievement in geometry.

ANCOVA result on table 4.7 revealed a significant main interaction effect of conventional method, motivation and attitude on SSS students' academic achievement in geometry; [ $F_{(1,135)} = 8.058$ ;  $P < .05$ ], hence, the  $H_0$  is rejected.

### 4.3 Discussion of Findings

The findings of this study are discussed based on the objectives of the study as guided by research hypotheses. Fourteen (14) hypotheses were raised and tested to guide the study. The first four hypotheses were tested to test for the main effects of CAI, conventional method, motivation and attitude on students' academic achievement in geometry.

The first objective of this study is to investigate the main effect of computer aided instruction on students' academic achievement in geometry. The study's findings unequivocally demonstrate the efficacy of CAI in enhancing senior secondary students' academic achievement in geometry. Notably, students exposed to CAI exhibited significantly higher scores on geometry tests compared to their counterparts who received traditional instruction. This result is consistent with previous research that has shown the effectiveness of CAI in improving student outcomes; incorporation of CAI in the teaching of Mathematics enhanced the achievement of students more than the conventional teaching method<sup>1</sup>

This outcome underscores the potential of CAI to revolutionize geometry education. By providing interactive visualizations and simulations, CAI facilitates a deeper understanding of geometric concepts, thereby enhancing problem-solving skills and spatial reasoning. Moreover, the study reveals that CAI's benefits transcend demographic boundaries and prior knowledge levels, making it an inclusive and effective instructional tool. The integration of CAI into geometry instruction has far-reaching implications. Educators can leverage CAI to provide personalized learning experiences,

addressing individual students' needs and learning styles. This, in turn, can foster a more engaging and effective learning environment.

Several factors contribute to CAI's effectiveness. Interactive visualizations enable students to explore geometric concepts in an immersive and interactive manner. Immediate feedback and assessment promote active learning, while CAI's adaptability accommodates diverse learning styles and pace. However, the study's findings also highlight areas for further investigation. Future research should explore the long-term effects of CAI on students' retention and application of geometric knowledge. Additionally, comparisons with other instructional methods, such as blended learning, would provide valuable insights. In conclusion, this study provides compelling evidence supporting the effectiveness of CAI in geometry education. As educators and policymakers seek innovative solutions to improve teaching and learning outcomes, CAI emerges as a promising strategy worthy of consideration.

Second objective of the study is to investigate the main effect of conventional teaching methods on students' academic achievement in Geometry. The findings of this study reveal a significant main effect of formative feedback on students' The study's results reveal a striking absence of a significant main effect of conventional teaching methods on senior secondary students' academic achievement in geometry. This finding raises important questions about the efficacy of traditional instructional approaches in fostering meaningful learning outcomes.

Contrary to expectations, the data indicates that conventional teaching methods do not have a substantial impact on students' understanding and retention of geometric concepts. This outcome is in line with past studies which suggests that the long-standing

reliance on traditional teaching methods may be insufficient to meet the diverse needs of senior secondary students<sup>2,3,4</sup>. The implications of this finding are far-reaching. Educators must reassess their teaching practices, shifting focus from rote memorization to critical thinking, problem-solving, and real-world applications. The study underscores the need for innovative instructional strategies that prioritize student-centered learning, interactive engagement, and hands-on experience.

Several factors may contribute to the ineffectiveness of conventional teaching methods. These include an overemphasis on memorization, lack of interactive elements, and failure to connect geometric concepts to practical contexts. To address these limitations, educators should explore alternative approaches, such as Computer-Aided Instructions (CAI). Moreover, the study highlights the importance of technology integration in geometry education. Computer-Aided Instructions (CAI), for instance, offer interactive visualizations and simulations that can enhance students' understanding and retention of geometric concepts. The results imply that educators should reconsider their reliance on conventional teaching strategies and explore alternative approaches that promote active learning, critical thinking, and problem-solving. Innovative methods, collaborative learning, or technology-enhanced instruction, may be more effective in enhancing student learning outcomes in geometry.

The third objective is to examine the main effect of students' motivation on students' academic achievement in geometry. The study revealed a significant main effect of students' motivation on academic achievement in geometry. Students with positive motivation demonstrated higher geometry scores, while those with negative motivation showed lower achievement.

This finding underscores the critical role of perception in geometry education. Positive motivation significantly enhances geometry performance, whereas negative motivation hinders achievement.

The implications are profound. Educators should prioritize motivation-focused interventions, and teacher training should emphasize motivation-sensitive instruction. Geometry curriculum design should also incorporate perception-focused strategies. To optimize student achievement, educators should foster positive attitudes, address negative motivation, and encourage student self-reflection.

The fourth objective is to examine the main effect of attitude on students' academic achievement in geometry. Similarly, the findings of this study revealed significant main effect of attitude on students' academic performance in geometry. The study's findings underscore the profound impact of students' attitudes on their academic achievement in geometry. A significant main effect emerged, revealing that students' attitudes exert a considerable influence on their learning outcomes in geometry. Positive attitudes toward geometry were found to be a potent predictor of academic success. Students who harbored enthusiasm and interest in the subject demonstrated superior performance compared to their peers who held negative attitudes. This striking correlation highlights the critical role that attitudes play in shaping students' motivation, engagement, and ultimately, their geometric literacy. The Implications of this discovery are far-reaching. Educators must now prioritize the cultivation of positive attitudes toward geometry, emphasizing its relevance, beauty, and practical applications. By doing so, teachers can foster an environment conducive to learning, where students are motivated to explore and understand geometric concepts.

Factors contributing to the attitude-achievement nexus include interest, confidence, and anxiety. Students who find geometry intriguing and enjoyable tend to perform better, while those beset by anxiety and self-doubt struggle to achieve academic success. Teachers must address these attitude-related barriers, providing interactive and engaging learning experiences that bolster confidence and mitigate stress. This finding aligns with previous research that has consistently shown significant influence of attitude on students' academic achievement<sup>8,9,10</sup>

The fifth objective is to examine the interactive effects of interaction effect of CAI and motivation on SSS academic achievement in geometry.

The study revealed a significant interaction effect between CAI and students' motivation on SSS academic achievement in geometry. This dynamic relationship highlights that CAI's effectiveness is influenced by students' motivation of their own learning capabilities. When students held positive motivation of their geometric abilities, CAI significantly enhanced their learning outcomes, fostering:

Deeper understanding of geometric concepts through interactive visualizations, improved problem-solving skills via engaging simulations and increased confidence and self-efficacy. Conversely, students with negative self-motivation did not benefit from CAI to the same extent. This underscores the critical role of students' motivation in moderating CAI's impact.

By acknowledging the interplay between CAI and students' motivation, educators can create an inclusive, engaging, and effective learning environment, unlocking senior secondary students' full potential in geometry.

The sixth objective of this study is to examine the interaction effect of CAI and attitude on SSS academic achievement in geometry.

The results from table 4.3 shows that there is significant interaction effect of CAI and attitude on Senior Secondary School students' academic achievement in geometry. The significant interactive effect of conventional teaching strategy and formative feedback on students' academic performance in geometry suggests that these two factors work together to enhance student learning outcomes. The study uncovered a significant interactive effect between CAI and attitude on SSS academic achievement in geometry. This dynamic relationship reveals that CAI's effectiveness is amplified when students possess positive attitudes toward geometry. When students exhibited enthusiasm and interest in geometry, CAI enhanced their learning outcomes, fostering deeper understanding of geometric concepts through interactive visualizations, improved problem-solving skills via engaging simulations and increased confidence and motivation. Conversely, students with negative attitudes toward geometry did not benefit from CAI to the same extent. This highlights the crucial role of attitudes in moderating the effectiveness of CAI.

The seventh objective of this study is to examine the interaction effects of conventional method and motivation on SSS academic achievement in geometry. The study's findings highlight a significant interaction effect between conventional teaching methods and students' motivation on SSS academic achievement in geometry. This dynamic relationship underscores the crucial role of students' motivation in moderating the effectiveness of traditional teaching methods.

When students possess a positive motivation of their geometric abilities, conventional teaching methods yield superior learning outcomes. These students demonstrate enhanced understanding, improved problem-solving skills, and increased confidence. Conversely, students with negative self-motivation do not benefit from conventional teaching methods to the same extent. This result is in agreement with past studies<sup>9,8,11,12</sup>. The implications of this finding are profound. Educators must prioritize fostering positive self-motivation in students, adapting instruction to accommodate diverse student motivations, and promoting supportive learning environments. Several factors contribute to this interactive effect include positive motivation empowers students to take ownership of their learning, conventional methods provide structure and clarity and teacher feedback strengthens positive motivation. By acknowledging the interplay between conventional teaching methods and students' motivation, educators can create inclusive, engaging, and effective geometry education.

Similarly, the eighth objective is to examine the interaction effects of effect of conventional method and attitude on SSS academic achievement in geometry.

The study revealed a significant interaction effect between conventional teaching methods and students' attitudes on SSS academic achievement in geometry. This dynamic relationship highlights that the effectiveness of traditional teaching methods is influenced by students' attitudes toward geometry. When students held positive attitudes, conventional teaching methods yielded better learning outcomes, characterized by improved understanding of geometric concepts, enhanced problem-solving skill and increased confidence and motivation. Conversely, students with negative attitudes did not

benefit from conventional teaching methods to the same extent. This underscores the critical role of attitudes in moderating the effectiveness of traditional instruction.

The ninth objective is to examine the interaction effect of motivation and attitude on SSS academic achievement in geometry.

From table 4.3 above, the result shows that the study revealed significant moderating effects of students' motivation and attitude on their academic achievement in geometry. The findings suggest that students with high motivation demonstrated improved academic achievement in geometry when using computer-assisted instructions. Motivation significantly influenced the effectiveness of computer-assisted instructions on geometry achievement. Highly-motivated students showed greater enthusiasm and engagement with computer-assisted learning. Attitude on the other side, students with positive attitudes toward geometry exhibited enhanced academic achievement when using computer-assisted instructions. Positive attitudes facilitated deeper understanding and application of geometric concepts. This finding implies that Educators should prioritize fostering motivation and positive attitudes in students. Teachers should monitor and address motivational and attitudinal challenges. The study therefore underscores the crucial role of motivation and attitude in students' academic achievement in geometry when using computer-assisted instructions. Educators and policymakers should prioritize fostering positive motivational and attitudinal environments

The tenth objective is to investigate the interaction effect of effect of conventional method, motivation and attitude on SSS academic achievement in geometry.

This study investigated the interaction effects of conventional teaching methods, student motivation, and attitude on academic achievement in geometry among senior

secondary school students. The results revealed a significant interplay between these variables, highlighting the pivotal role of motivation and attitude in moderating the effectiveness of conventional teaching methods. Notably, students who held positive motivation and attitudes toward geometry demonstrated improved academic achievement when instructed through conventional methods. Conversely, negative motivation and attitudes mitigated the efficacy of conventional teaching approaches.

Further analysis indicated that motivation mediated the relationship between conventional teaching methods and academic achievement. Attitude, meanwhile, moderated the impact of motivation on the effectiveness of conventional methods.

These findings have profound implications for educators and policymakers.

## Endnotes

1. C. Hayati, & D. Serap, *The Effect of Technology Assisted Teaching on Success in Mathematics and Geometry: A Meta-Analysis*, **Journal of Educational Psychology**, 1(3), 2022, 358 - 397.
2. B. Tamam & D. Dasari, *The use of Geogebra Software in Teaching Mathematics*, Journal of Physics Conference Series, The 1st South East Asia Science, Technology, Engineering and Mathematics International Conference, 2020.
3. S. T. Halime & A. Didem, *The Effects of Using Dynamic Geometry on Eighth Grade Students' Achievement And Attitude Towards Triangles*, **The International Journal for Technology in Mathematics Education**, 23(3), 2016, 95.
4. D. P. Asuman & U. Behiye, *Effects of Drama-Based Geometry Instruction on Student Achievement, Attitudes, And Thinking Levels*, **The Journal of Educational Research** 102(4), 2009, 272-286.
5. Esra, *An Investigation on The Effects of Project-Based Learning on Students' Achievement in and Attitude Towards Geometry*, Middle East Technical University, 2006
6. O. N.Cecilia, E. O.Richard, A. N.Hope, O. U.John, E. U. Uduak & A. I. Mary, *Students' Attitude and Academic Achievement in a Flipped Classroom*, **Journal of Science Learning**, 8(1), 2022.
7. H. Sunghwan, & S.Taekwon, *Students' Attitude toward Mathematics and Its Relationship with Mathematics Achievement*, **Journal of Education and e-Learning Research**, 8(3), 2021, 272-280.
8. A. Alfauzan, A. Alimni, A. K. Dwi, T. Elza & A. P. Wahyu, *Implications of Teacher Interpersonal Communication Ability on Student Learning Motivation in Islamic Religious Education Lessons During Pandemic*, **Journal of Education Research and Evaluation** 6 (1),2022, 156-167.
9. S. Hwang, & T. Son, *Students' Attitude toward Mathematics and its Relationship with Mathematics Achievement*, **Journal of Education and e-Learning Research**, 8(3), 2020, 272-280.
10. M.B. Ibáñez, A.U. Portillo, R.Z. Cabada & M.L. Barrón, *Impact of Augmented Reality Technology on Academic Achievement and Motivation of Students from Public and Private Mexican Schools: A Case Study in a Middle-School Geometry Course*, **Computers & Education**, 145, 2020, 103734.

## Chapter Five

### Conclusion

#### 5.1 Summary of Findings

The results of the ANCOVA, as shown in Table 4.2, indicate that there exist significant main effect Computer Aided Instruction [ $F_{(1, 145)} = 54.578$ ;  $P < .05$ ], Students' motivation [ $F_{(1,145)} = 5.582$ ;  $P < .05$ ], and attitude [ $F_{(1,145)} = 6.216$ ;  $P < .05$ ], on academic achievement of SSS in geometry. However, from the same table, the results show that conventional teaching method has no significant main effect on academic achievement of senior secondary students in geometry; [ $F_{(1,145)} = 1.556$ ;  $P > .05$ ].

Furthermore, results from table 4.3 shows that there were significant interaction effects CAI and conventional method on academic achievement of senior secondary students in geometry [ $F_{(1,139)} = 7.209$ ;  $P < .05$ ]; between CAI and students' motivation [ $F_{(1,139)} = 9.974$ ;  $P < .05$ ], between Computer Aided Instruction (CAI) and attitude [ $F_{(1,139)} = 3.272$ ;  $P < .05$ ], between conventional method and motivation [ $F_{(1,139)} = 9.974$ ;  $P < .05$ ], between conventional method and attitude [ $F_{(1,139)} = 7.209$ ;  $P < .05$ ], on academic achievement of SSS academic achievement in geometry.

Moreover, result from table 4.4 shows that that was significant 3 – ways interaction effect of Computer Aided Instruction (CAI), conventional method and motivation on student' academic achievement of senior secondary students in geometry [ $F_{(1,135)} = 8.058$ ;  $P < .05$ ]; amongst Computer Aided Instruction (CAI), conventional

method and attitude [ $F_{(1,135)} = 10.238$ ;  $P < .05$ ]; and amongst conventional method, motivation and attitude [ $F_{(1,135)} = 8.058$ ;  $P < .05$ ].

Finally, there was significant 4 ways interaction effects CAI, conventional method, motivation and attitude on students' academic achievement of SSS in geometry in Oluyole Local Government Area, Ibadan [ $F_{(1,134)} = 6.353$ ;  $P < .05$ ].

## **5.2 Conclusion**

This study determined the effects of CAI on SSS academic achievement in geometry in Oluyole Local Government, Oyo State. The research also explored the moderating effects of students' motivation and attitudes. The findings demonstrate that CAI significantly enhances students' academic achievement of geometric concepts. Notably, students' positive motivation and attitudes toward CAI amplify its effectiveness, leading to improved academic outcomes.

## **5.3 Recommendations**

To maximize the benefits of CAI in geometry education, the following recommendations are proposed:

- i. Educational institutions should prioritize CAI integration by providing necessary infrastructure and technical support. Teacher training and capacity building are essential for effective CAI utilization.
- ii. Teachers play a crucial role in fostering a positive learning environment. They should incorporate interactive CAI materials into lesson plans, encourage students' enthusiasm for technology, and address difficulties promptly.

- iii. Policy makers can support CAI adoption by developing policies, allocating resources, and fostering collaboration between educators, policymakers, and technology experts.

#### **5.4 Contribution to Knowledge**

This study makes significant contributions to the existing body of knowledge on computer-assisted instruction (CAI) in geometry education.

By providing quantitative evidence on CAI's effectiveness, this research fills a critical gap in the literature. The findings inform educators and policymakers on evidence-based strategies for CAI implementation, bridging the gap between research and practice.

Methodologically, this study demonstrates the effectiveness of quantitative research design in assessing CAI's impact. Theoretically, the study supports cognitive load theory and self-efficacy theory in mathematics education, deepening understanding of learning processes. Practically, this research has far-reaching implications for educational policy, promoting informed decision-making.

Ultimately, this study lays the groundwork for future research, providing a foundation for longitudinal studies, comparative analyses, and investigations into CAI's effects on diverse populations. By advancing understanding of CAI's potential, this research contributes meaningfully to enhancing geometry education.

## 5.5 Suggested Areas for Further Research

To deepen understanding and explore new avenues, future research should consider:

1. Longitudinal studies: Assess CAI's long-term impact on students' academic achievement and retention.
2. Comparative analysis: Compare CAI's effectiveness with traditional teaching methods.
3. Diverse populations: Investigate CAI's impact on students with varying learning styles, abilities, and socioeconomic backgrounds.
4. Teacher factors: Examine teacher characteristics, training, and support on CAI implementation.
5. Integration with other technologies: Explore combining CAI with other educational technologies such as virtual reality, gamification and so on.
6. Subject-specific CAI: Develop and evaluate CAI materials for other mathematics subjects (e.g., algebra, calculus).

## Bibliography

### Journals

- Adeniji, A. Lawal, B. & Daudu, A. *Effect of Mastery Learning Approach on Senior School Students' Academic Performance and Retention in Circle Geometry*, **International Journal of Instruction**, 11(4), 2018, 951-962
- Aiyim, Y. Galiya, K. Ademi, B., Adilet, M., Kamshat, Z. & Gulmira, K. *Development of the Logical Thinking of Future Mathematics Teachers through the use of Digital Educational Technologies*, **Cypriot Journal of Educational Sciences**, 17(6), 2022, 105-109. Available online: doi:10.18844/cjes.v17i6.7548
- Alfauzan, A. Alimni, A. K.Dwi, A. Elza, T. & Wahyu, A. P. *Implications of Teacher Interpersonal Communication Ability on Student Learning Motivation in Islamic Religious Education Lessons During Pandemic*, **Journal of Education Research and Evaluation**, 6(1), 2022, 156-167.
- Alheri, P. K., U. Burgasa, A. Isah & Y. Gambo, *Motivation and Academic Achievement of Students Toward Sustainable National Development in Nigeria: A Pragmatic Approach*, **African Journal of Humanities and Contemporary Education Research**, 6(1), 2022, 69-79.
- Ansah, J. K. Quansah, F. & Nugba, R. M., *Mathematics Achievement in Crisis: Modelling the Influence of Teacher Knowledge and Experience in Senior High Schools in Ghana*, **Open Education Studies Journal**, 2(1), 2020, 265-276. Available online: doi: 10.1515/edu-2020-0129
- Arik, S. & Yilmaz, M., *The effect of Constructivist Learning Approach and Active Learning on Environmental Education: A Meta Analysis Study*, **International Journal of Science Education and Environmental**, 3(1), 2020, 154.
- Arthur, Y. D., *Mathematics Teachers' Acceptance of ICT in Teaching and Learning: An Extended Technology Acceptance Model*, **Problems of Education in the 21st Century**, 80(3), 2022, 408-425. Available online doi:10.33225/pec/22.80.408
- Asuman, D. P. & Behiye, U., *Effects of drama-based geometry instruction on student achievement, attitudes, and thinking levels*, **The Journal of Educational Research** 102 (4), 2009, 272-286.
- Bayanova, A. R., Orekhovskaya N. A., Sokolova N. L., Shaleeva E. F., Knyazeva S. A. & Budkevich R. L., *Exploring the Role Of Motivation In Stem Education: A Systematic Review*, **Eurasia Journal Of Mathematics, Science And Technology Education**, 2022, 18(4), Em2250. Available online: <https://Doi.Org/10.29333/Ejmste/13086>

- Birgin, O. & Acar, H., *The Effect of Computer-Supported Collaborative Learning using GeoGebra Software on 11th Grade Students' Mathematics Achievement in Exponential and Logarithmic Functions*, **International Journal of Mathematical Education in Science and Technology**, 53(4), 2022, 872-889.
- Bosson-Amedenu, S., *Pre-SHS Students' Perception of Difficult Concepts in Junior High School Mathematics Curriculum in Ghana*, **Asian Research Journal of Mathematics**, 3(2), 2018, 1-11. Available online: doi:10.9734/arjom/2017/32329
- Boyd, P. & Ash, A., *Mastery Mathematics: Changing Teacher Beliefs around In-class Grouping and Mindset*, **Teaching and Teacher Education**, 75, 2018, 214-223. Available online: doi:10.1016/j.tate.2018.06.016
- Bülbül, B. Ö. & Güler, M., *Can Geometry Achievement and Geometric Habits of Mind Be Improved Online? Reflections from a Computer-Aided Intervention*, **Journal of Educational Technology Systems**, 49(3), 2021, 376-398.
- Carlson, J. Daehler, K. R., Alonzo, A. C. Barendsen, E. Berry, A. Borowski, A. Wilson, C. D., *The Refined Consensus Model of Pedagogical Content Knowledge in Science Education*, **Science Pedagogy**, 4(8), 2019, 77-94. Available online: doi: 10.1007/978-981-13-5898-2-2
- Cecilia, O. N., Richard, E. O., Hope, A. N., John, O. U. Uduak, E. U. & Mary A. I., *Students' Attitude and Academic Achievement in a Flipped Classroom*, **Journal of Science Learning**, 8(1), 2022, 122.
- Cementina, S., *Language Teachers' Digital Mindsets: Links between Everyday Use and Professional Use of Technology*, **TESL Canada Journal**, 36(3), 2019, 31-54. Available online: doi: 10.18806/tesl.v36i3.1320
- Chand, S., Chaudhary, K. Prasad, K & Chand, V., *Perceived Causes of Students' Poor Performance in Mathematics: A Case Study at Ba and Tavua Secondary Schools*, **Frontiers in Applied Mathematics and Statistics**, 7, 2021, 75-86. Available online: doi: 10.3389/fams.2021.614408
- Chen, X., Alan, C. K., Wilfred, W. F. & Robert, E. S., *Effects of Computer Assisted Instruction on Mathematics Achievement in Mainland China: A Meta-Analysis*, **International Journal of Educational Research**, 2, 2020, 102.
- Ekundayo, S. K *Effects of Computer-Assisted Instruction (CAI) on Students Academic Achievement in Chemistry among Boys and Girls in Public Secondary Schools in Ondo State, Nigeria*, **British Journal of Education**, 10(2), 2022, 31-41. Available online: <https://doi.org/10.37745/Bje.2013>
- Enoch, A. Steven, B. & John, K., *Teachers' Geometry Vocabulary Competence and Students' Academic Performance in Circle Theorem*, **Journal of Education and Practice**, 14(19), 2023, 13-20.

- Fatimah, S. & Rosidin, D. N., *Student-based Learning in the Perspective of Constructivism: Theory and Maieutics Method*, **International Journal of Science Education**, 3(4), 2020, 134.
- Fred, D. D., Richard, P. B. & Paul, R. W., *User Acceptance of Computer Technology: Comparison of Two Theoretical Models*, **Journal of Management Science**, 6(3), 2022
- Fred, P. Alexander, R. & John, S., *Cognitive Load Theory and the Format of Instruction*, **Cognition and Instruction Journal**, 5(7), 2003, 133.
- Gaspard, H., Wille, E. Wormington, S. V. & Hulleman, C. S., *How are Upper Secondary School Students' Expectancy-Value Profiles Associated with Performance and University STEM Major? A Cross-Domain Comparison*, **Contemporary Educational Psychology**, 58, 2019, 149-162. Available online: doi: 10.1016/j.cedpsych.2019.02.005
- Halime, S. T. & Didem, A., *The Effects of Using Dynamic Geometry on Eighth Grade Students' Achievement and Attitude towards Triangles*, **The International Journal for Technology in Mathematics Education**, 23(3), 2016, 95.
- Halime, S. T. & Didem, A., *An Investigation on the Effect of STEM Practices on Sixth Grade Students' Academic Achievement, Problem Solving Skills, and Attitudes towards STEM*, **The International Journal for Technology in Mathematics Education**, 23(3), 2016, 95.
- Haruna M. M. & Ambode A. B., *Effects of Computer Assisted Instruction on Learning Outcome in Science Subjects Among Secondary School Students in Kogi State, Nigeria*, **Custech International Journal Of Economics**, 7, 2024, 214.
- Hayati, C. & Serap, D., *The Effect of Technology Assisted Teaching on Success in Mathematics and Geometry: A Meta-Analysis*, **Journal of Educational Psychology**, 1(3), 2022, 358 – 397.
- Hidayatullah, A. & Csikos C., *The Role of Students' Beliefs, Parents' Educational Level, and The Mediating Role of Attitude and Motivation in Students' Mathematics Achievement*, **The Asia-Pacific Education Researcher**, 33(2), 2024, 253-262.
- Hosseini, H., Mehdizadeh, Z., Sadegi, M. & Maryam, K., *Using GeoGebra in Teaching Geometry to Enhance Students Academic Achievement and Motivation*, **Innovation Journal of Education**, 10(3), 2022, 34-38.
- Huaruo, C., Ya, W. & Jiuren, J. *computer teaching and learning of basic elementary functions*, **Heliyon Journal**, 6(7), 2023, 57-58
- Hwang, S. & Son, T., *Students' Attitude toward Mathematics and its Relationship with Mathematics Achievement*, **Journal of Education and e-Learning Research**, 8(3), 2021, 272-280.

- Jamilu, A.G., *Effect of Computer-Assisted Instruction on Students' Academic Performance and Retention in Chemistry Concepts*, **Journal Of Science, Technology, Mathematics Pedagogy**, 2(1), 2024.
- Jan, L. P., & Jamilu A. G., *Effect of Computer-Assisted Instruction on Students' Academic Performance and Retention in Chemistry Concepts*, **Journal Of Science, Technology, Mathematics Pedagogy**, 2(1), 2024.
- Juandi, D., Kusumah, Y.S., Tamur, M., Perbowo, K. S. & Wijaya, T. T., *A Meta-Analysis of Geogebra Software Decade of Assisted Mathematics Learning: What to Learn and Where To Go?*, **A Research Article**, 7(5), 2021.
- Juandi, D., Kusumah, Y., Tamur, M., Perbowo, K. Siagian, M., Sulastri, R. & Negara, H., *The Effectiveness of Dynamic Geometry Software Applications in Learning Mathematics: A Meta-Analysis Study*, **International Association of Online Engineering**, 7(2), 2021, 132-140.
- Kiran, R. & Yildiz, F. E., *Development of Self-Efficacy for Argumentation Scale*, **Kuramsal Eğitimbilim**, 14(3), 2021, 449-475. Available online: doi: 10.30831/akukeg.891057
- Kusumah, Y. S., Kustiawati, D. & Hermarn, T., *The Effect of GeoGebra in Three-Dimensional Geometry Learning on Students' Mathematical Communication Ability*, **International Journal of Instruction**, 13 (2), 2020, 895-908.
- Lawal, A., *Effect of Computer-Aided Instruction on the Performance of Senior Secondary School Students in Geometry in Katsina, Katsina State, Nigeria*, **International Journal of Management, Social Sciences, Peace and Conflict Studies**, 3(2), 2020, 124-129
- Maha., Y. & Nadera, A. Z., *Ecological Systems Theory: A Strengths-Based Approach for Understanding and Addressing Child Behavioral Problems*, **International Journal of Higher Education**, 7, 2020. 217.
- Mao, P., Z. Cal, J. He, X. Chen, & X. Fan, *The Relationship Between Attitude Toward Science And Academic Achievement In Science: A Three -Level Meta-Analysis*, **Frontiers in Psychology**, 12, 2021, 784068.
- Mark, A. M. & Jessica, E. M. *"Ecological Systems Theory in Education Research: Conceptual Underpinnings and Practical"*, **Educational Researcher**, 10, 2008, 128.
- Mensah, J.Y. & Nabie, M. J., *The Effect of PowerPoint Instruction on High School Students' Achievement and Motivation to Learn Geometry*, **International Journal of Technology in Education**, 4(3), 2021, 331-350.
- Moreno-Guerrero, A. Garcia, M. R., Heredia, N. M. Rodríguez-García, A., *Collaborative Learning based on Harry Potter for Learning Geometric Figures in the Subject of Mathematics*, **International Journal of Mathematics**, 8(3), 2020, 369.

- Nkiko, M.O., *Interrogating The Teaching And Learning Of Chemistry In Nigerian Private Universities: Matters Arising*, **Journal Of Education And Learning**, 10(3), 2021, 135.
- Nwoke, B. *Enhancing Senior Secondary School Students' Performance in Geometry through Origami Instructional Approach*, **International Journal of Science Education and Environmental**, 3(1), 2020, 46.
- Olga, K. & Igor, K., *Zone of Proximal Development (ZPD): A Conceptual Tool for Building the Learning Process*, **Social and Behavioral Sciences**, 7(8), 2021, 87.
- Owede, KosiomaEli , *Use Of Computer Aided Instructions (CAI) at Secondary School on Academic Performance of Undergraduates in Bayelsa State*, **Journal Of Educational Research**, 7, 2024, 145.
- Ramatu, H., *Effects Of Computer -Assisted Instruction On Achievement, Of Junior Secondary School Students In Social Studies In Niger State, Nigeria*, **International Journal of Science Education and Environmental**, 3(1), 2022, 456.
- Ramatu, H., *Effects of Computer – Assisted Instruction on Varied Ability Groups among Junior Secondary School Students in Social Studies in Niger State, Nigeria*, **International Journal of Science Education and Environmental**, 3(1), 2022, 143.
- Rosali, L. J. D., *Effect of Computer-Assisted Instruction (CAI) on the Academic Achievement in Secondary Physics*, **Open Access Library Journal**, 7, 2020, e6319. Available online: <https://Doi.Org/10.4236/Oalib.1106319>.
- Ruud, J. G., *Ecological Systems Theory: A Valuable Framework for Research on Inclusion and Special Educational Needs*, **European Journal of Special Needs Education**, 2004
- Ruth, C. C. & Richard, E. M., *Cognitive Load Theory: Instructional Implications for the Design of Multimedia*, **Journal of Educational Psychology**, 5(7), 2021, 146.
- Sarkar P., Kadam K. & Pillai J. S., *Learners' Approaches, Motivation and Patterns of Problem-Solving on Lines and Angles in Geometry using Augmented Reality*, **International Journal of Science Education and Environmental**, 7(17), 2020, 124-133.
- Salifu, A. S., Nabie, M. J. & Apawu, J., *College of Education Pre-Service Teachers' Attitude in Terms of Usefulness, Confidence and Enjoyment towards Geometry by Gender*, **Contemporary Mathematics and Science Education**, 2(2), 2021, ep21012.
- Serin, H., *The Impact of Technology-Aided Instruction on Motivation of Geometry Learners*, **International Journal of Social Sciences & Educational Studies**, 7 (3), 2020, 63-72.

- Sudirman, S. Mellawaty, M. Poppy, Y. & Rully, I., *Integrating Local Wisdom Forms In Augmented Reality Application: Impact Attitudes, Motivations And Understanding Of Geometry Of Pre-Service Mathematics Teachers*, **International Association of Online Engineering**, 3(1), 2020, 127.
- Süren, N. & Kandemir, M. A., *The Effects of Mathematics Anxiety and Motivation on Students' Mathematics Achievement*, **International Journal of Education in Mathematics, Science and Technology**, 8(3), 2020, 190-218.
- Sudirman, S., Mellawaty, M., Yaniawati, P. & Indrawan, R., *Integrating Local Wisdom Forms in Augmented Reality Application: Impact Attitudes, Motivations and Understanding of Geometry of Pre-service Mathematics Teachers*, **International Association of Online Engineering**, 10(2), 2020, 134-142. Available online: <https://www.learntechlib.org/p/217753/>.
- Sunghwan, H. & Taekwon S., *Students' Attitude toward Mathematics and Its Relationship with Mathematics Achievement*, **Journal of Education and e-Learning Research**, 8 (3), 2021, 272-280.
- Tamam, B. & Dasari, D., *The use of Geogebra Software in Teaching Mathematics*, **Journal of Physics Conference Series, The 1st South East Asia Science, Technology, Engineering and Mathematics International Conference**, 1(8), 2020, 128.
- Tabuenal, C. A. & Pentang, J., *Learning Motivation and Utilization of Virtual Media in Learning Mathematics*, **Asia-Africa Journal of Recent Scientific Research**, 1, 2021, 65-75.
- Ukaigwe, P. C. & Goi-tanen, K. E. "Effects of Computer Assisted Instruction on Mathematics Achievement among Secondary School Students in Rivers State, Nigeria", **International Journal of Research and Innovation in Social Science**, 6, 2022, 341-347.
- Uwurukundo, M. S., Maniraho, J. F. & Rwibasira, M. T., *Effect of GeoGebra Software on Secondary School Students' Achievement in 3-D Geometry*, **Education and Information Technologies**, 27 (4), 2022, 5749-5765.
- Uwurukundo, M. S., Maniraho, J. F., Tusiime, M., Ndayambaje, I. & Mutarutinya, V., *GeoGebra Software in Teaching and Learning Geometry of 3-Dimension to Improve Students' Performance and Attitude of Secondary School Teachers and Students*, **Education and Information Technologies**, 29 (8), 2024, 10201-10223.
- Viktor Shurygin, Ilyos Abdullayev, Hafis Hajiyevev, Marina Yakutina, Artemiy Kozachek, Rafina Zakieva *Blended Learning: The Effect On Students' Self-Regulation And Academic Achievements*, **International Journal of Science Education and Environmental**, 3(1), 2024, 31-48.

Viswanath, V. & Fred, D. D., *Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior*, **Information Systems Research**, 6(9), 2020, 47-54

Wassie, Y. A. & Zergaw. G. A., *Some of the Potential Affordances, Challenges and Limitations of Using GeoGebra in Mathematics Education*, **Eurasia Journal of Mathematics, Science and Technology Education**, 15(8), 2019, 1734.

Xana, M. & Roland, V., *Cognitive Load Theory and Instructional Design: Recent Developments*, **Educational Psychologist**, 7, 2010, 1-12.

Zulnaidi, H. Oktavika, E. & Hidayat, R., *Effect of Use of GeoGebra on Achievement of High School Mathematics Students*, **Education and Information Technologies**, 25 (1), 2020, 51-72.

### **Dissertation**

Arigbabu, A. A, O. W. Lawal, A. R. Hassan, T O. Abiodun, & S. O. Ganiyu, *Perception Of Teachers And Students On The Use Of Mobile Applications In Teaching And Learning Of Mathematics*, Department Of Mathematics, Tai Solarin University Of Education Ijagun, Ogun State, Nigeria, 2021.

Esra, O., *An Investigation on the Effects of Project-Based Learning on Students' Achievement in and Attitude towards Geometry*, Middle East Technical University, 2006.

Mensah, J. Y., *Effect of ICT Integration on Senior High Students' Motivation and Achievement in Geometry, The Case of Gomoa West District*”, A Dissertation in the Department of Mathematics Education, in the University of Education, Winneba, 2019.

### **Textbooks**

Albert, B., *Social Learning Theory*, Prentice Hall, 1977

Albert, B., *Social Learning Theory of Aggression*, Communication Review, 1978

Albert, B., *Modeling Processes in Social Learning*, Advances in Experimental Social Psychology, 1965

Barbara, R. & Jayanthi, M., *Guided Participation in Cultural Activity by Toddlers and Caregivers*, Cambridge University Press, 1990

Barbara, R., *The Zone of Proximal Development: Where Culture and Cognition Create Each Other*, The Sage Handbook of Cultural Analysis, 2008

- Catherine, T. F. & Randall, S. P., *Constructivism: Theory, Perspectives, and Practice*, Teachers College Press, 2005.
- Catherine, T. F. & Carollee, H., *Constructivist Learning Design: Key Questions for Teaching to Standards*, Teachers College Press, 2005.
- Constantinou, C., *Implications of Mathematics Standards on Geometry Education in New York States*, 2018.
- John, S. Paul, A. & Slava, K., *Cognitive Load Theory*, Springer, 2011.
- John, W. & Creswell, J. D. C., *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, New Delhi: SAGE, 2018.
- Leslie, P. S., *Constructivism in Education*, Lawrence Erlbaum Associates, 1995.
- Lev, V., *Mind in Society: The Development of Higher Psychological Processes*, Harvard University Press, 1978.
- Marie, L. Nadine, B. & James, G., *Constructivism: Its Foundations and Applications*, Lawrence Erlbaum Associates, 1998.
- Neal E. M. & John, D., *Social Learning and Imitation*, Yale University Press, 1941.
- Robert, L. B. & Ronald, L. A., *Social Learning Theory and the Process of Imitation*, American Sociological Review, 1966
- Shirley, G. & David, J., *Information Systems Research: Relevant Theory and Informed Practice*, Routledge, 2007
- Stephen, L., *Applying Cognitive Learning Theory to Adult Learning*, Information Age Publishing, 1991
- Urie, B., *Ecological Systems Theory*, Harvard University Press, 1979
- Urie B. & Pamela, A. M., *Making Human Beings Human: Bioecological Perspectives on Human Development*, SAGE Publications, 2006
- Urie, B., *Ecological Systems Theory, Readings on the Development of Children*, Worth Publishers, 2002
- Urie, B., *The Ecology of Human Development: Experiments by Nature and Design*, Harvard University Press, 1979.
- Viswanath, V., *The Role of Perceived Usefulness, Perceived Ease of Use, and Social Influence in the User Acceptance of Information Technology*, MIS Quarterly, 2003

## Appendix I

### Mathematics Achievement Test (MAT)

#### Instruction:

**In section A:** Please provide an appropriate answer to the following questions

**In section B:** Please shade only one answer at a time from the given options

**Duration:** 40 minutes

#### Section A

##### Demographic Characteristics of Participant

**School Name:** \_\_\_\_\_

**Gender:** Male  Female

**Parents Occupation:** Civil Servant  Public Servant

Private Sector  Business Trading

**Test type:** pretest  post test

#### Section B

1. A Chord subtends an angle of  $72^{\circ}$  at the centre of a circle of radius 24.5m. Calculate the perimeter of the minor segment.  
A. 59.6cm  
B. 58.6 cm  
C. 70.6 cm  
D. 55.6 cm
2. The diameter of a cylinder closed at both ends 7cm. if the total surface area is  $209\text{cm}^2$ . Calculate the height [Take  $\pi = \frac{22}{7}$ ]  
A. 6 cm  
B. 10 cm  
C. 3 cm  
D. 5cm

3. A cone has a base radius of 8cm and height 11cm. calculate curved surface area correct to two decimal places (Take  $\pi = \frac{22}{7}$ )
- 314.98cm<sup>2</sup>
  - 276.57cm<sup>2</sup>
  - 201.14cm<sup>2</sup>
  - 477.71cm<sup>2</sup>
4. The ratio of the radius to the slant height of a right circular cone is 2.5. if the total surface area of the cone is  $224\pi\text{cm}^2$ , calculate the slant height
- $\frac{5r}{2}$
  - $\frac{5r}{4}$
  - $\frac{r}{2}$
  - 5r
5. The dimensions of a rectangular base of a right pyramid are 9cm by 5cm. if the volume of the pyramid is 105cm<sup>3</sup> how is the height of the pyramid?
- 10cm
  - 6cm
  - 8cm
  - 7cm
6. A solid cuboid has length 7cm, width 5cm and height 4cm. calculate its total surface area.
- 280cm<sup>2</sup>
  - 166cm<sup>2</sup>
  - 140cm<sup>2</sup>
  - 83cm<sup>2</sup>
7. A sector of a circle with radius 6cm subtends an angle of 60° at the centre. Calculate its perimeter in terms of  $\pi$
- $2(\pi + 6)\text{cm}$
  - $2(\pi + 3)\text{cm}$
  - $2(\pi + 2)\text{cm}$
  - $(\pi + 12)\text{cm}$
8. The dimensions of a rectangular tank are 2m by 7m by 11m. if its volume is equal to that of a cylindrical tank of height 4cm. calculate the base radius of the cylindrical tank. [Take  $\pi = \frac{22}{7}$ ]
- 14cm
  - 7m
  - 3<sup>1</sup>/<sub>2</sub>m

- D.  $1\frac{3}{4}m$
9. The slant height of a cone is 5cm and the radius of its base is 3cm. find correct to the nearest whole number, the volume of the cone. (Take  $\pi = \frac{22}{7}$ )
- A.  $38\text{ m}^3$   
B.  $33\text{ m}^3$   
C.  $28\text{ m}^3$   
D.  $23\text{ m}^3$
10. A cylinder with base radius 14cm has the same volume as a cube side 22cm. calculate the ratio of the total surface area of the cylinder to that of the cube [Take  $\pi = \frac{22}{7}$ ]
- A. 73:77  
B. 77; 74  
C. 63: 77  
D. 73:73
11. The volume of a cuboid is  $54\text{cm}^3$ . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total area
- A.  $108\text{cm}^2$   
B.  $90\text{cm}^2$   
C.  $80\text{cm}^2$   
D.  $75\text{cm}^2$
12. A sector of a circle with radius 6cm subtends an angle  $60^\circ$  at the centre. Calculate its perimeter in forms of  $\pi$
- A.  $2(\pi + 6)\text{cm}$   
B.  $2(\pi + 3)\text{cm}$   
C.  $2(\pi + 8)\text{cm}$   
D.  $2\pi(\pi + 6)\text{cm}$
13. The volume of a cone of height 3cm is  $38\frac{1}{2}\text{cm}^3$ . Find the radius of its base
- A.  $r = 3\frac{1}{2}$   
B.  $r = 2\frac{1}{2}$   
C.  $r = 3\frac{1}{4}$   
D.  $r = 3\frac{2}{3}$
14. The radii of the base of two cylindrical tins, P and Q are r and 2r respectively. If the water level in P is 10cm high. What would be the height of the same quantity of water.
- A. 2.5 cm  
B. 2.3 cm  
C. 2.8 cm  
D. 3.5 cm
15. The volume of a cuboid is  $54\text{cm}^3$ . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total surface area.

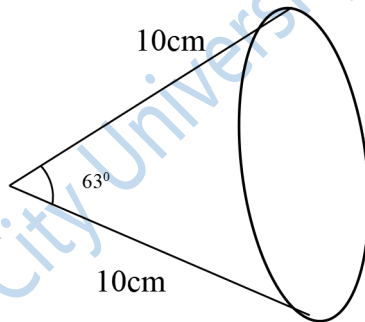
- A.  $96 \text{ cm}^2$
- B.  $90 \text{ cm}^2$
- C.  $86 \text{ cm}^2$
- D.  $94 \text{ cm}^2$

16. A sector of a circle of radius 14cm containing an angle  $60^\circ$  is folded to form a cone. Calculate the radius of the base of cone
- A. 3.5cm
  - B. 3 cm
  - C. 7 cm
  - D. 3.3 cm

17. The angle of a sector of a circle of radius 8cm is  $240^\circ$ . This Sector is bent to form a cone. Find the radius of the cone.
- A.  $\frac{16}{3} \text{ cm}$
  - B.  $\frac{17}{3} \text{ cm}$
  - C.  $\frac{16}{5} \text{ cm}$
  - D.  $\frac{18}{3} \text{ cm}$

18. The angle of a sector of a circle radius 7cm is  $180^\circ$  calculate the perimeter of the sector (Take  $\pi = \frac{22}{7}$ )
- A. 27.2 cm
  - B. 27 cm
  - C. 28cm
  - D. 27.5cm

19.



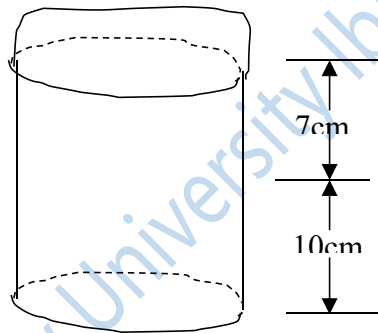
- Calculate the area of the shaded segment of the circle shown in the diagram (Take  $\pi = \frac{22}{7}$ )
- A.  $10.45 \text{ cm}^2$
  - B.  $11.4 \text{ cm}^2$
  - C.  $10.5 \text{ cm}^2$
  - D.  $13.48 \text{ cm}^2$

20. The angle of a sector of a circle radius 10.5cm is  $120^\circ$ . find the perimeter of the sector (Take  $\pi = \frac{22}{7}$ )
- A. 43 cm
  - B. 42 cm
  - C. 41 cm

D. 44 cm

21. A sector of a circle radius 6cm had an angle of  $105^\circ$  at the centre calculate its (i) Perimeter (Take  $\pi = \frac{22}{7}$ )
- A. 33 cm  
B. 54 cm  
C. 50 cm  
D. 25 cm
22. The angle of a sector of a circle of radius 35cm is  $288^\circ$ . Find the perimeter of a sector [Take  $\pi = \frac{22}{7}$ ]
- A. 246 cm  
B. 357 cm  
C. 462 cm  
D. 200 cm
23. Calculate the total surface area of a solid cone of slant height 15cm and base radius 8cm in terms of  $\pi$
- A.  $184\pi \text{ cm}^2$   
B.  $164\pi \text{ cm}^2$   
C.  $123 \text{ cm}^2$   
D.  $176\pi \text{ cm}^2$

24.



The solid is a cylinder surmounted by a hemispherical bowl calculate its volume ( $\pi = \frac{22}{7}$ )

- A.  $2258.67 \text{ cm}^3$   
B.  $2345.21 \text{ cm}^3$   
C.  $3567.34 \text{ cm}^3$   
D.  $5743.87 \text{ cm}^3$
25. A solid cylinder of radius 7cm, is 10cm long. Find its total surface area
- A.  $238\pi \text{ cm}^3$   
B.  $84\pi \text{ cm}^3$   
C.  $184\pi \text{ cm}^3$   
D.  $254\pi \text{ cm}^3$

**Answer**

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

## Appendix II

### Students' Attitude Questionnaire (SAQ)

Section B: Please note the following abbreviation SA= Strongly Agree, A= Agree, N= Neutral, D=Disagree, SD= Strongly Disagree

S/NO		SA	A	N	SD	D
1	CAI helps me understand geometry topics better.					
2	I feel more confident in my geometry abilities when using CAI.					
3	I believe CAI is a valuable tool for supplementing classroom instruction in geometry.					
4	CAI helps me visualize geometry concepts more clearly.					
5	I am satisfied with the variety of resources available through CAI for learning geometry.					
6	I believe CAI can help bridge the gap for students who struggle with geometry.					
7	I believe CAI should be integrated more extensively into the geometry curriculum.					
8	Using CAI for geometry enhances my overall academic achievement.					
9	I feel more prepared for geometry assessments after using CAI.					
10	I would recommend the use of CAI to my peers for learning geometry topics.					

### Appendix III

#### Students' Motivation Questionnaire (SMQ)

S/NO		SA	A	N	SD	D
1	I enjoy learning geometry in school.					
2	I feel motivated to study geometry because it is interesting.					
3	Geometry helps me understand the world around me better.					
4	I am confident in my ability to solve geometry problems.					
5	Learning geometry will be helpful for my future education or career.					
6	I find geometry easier to learn compared to other math topics.					
7	I am motivated to learn geometry because it improves my logical thinking.					
8	I enjoy practicing geometry problems outside of class.					
9	I feel a sense of accomplishment when I solve a difficult geometry problem.					
10	Geometry is one of my favorite subjects in school.					
11	Learning geometry will help me achieve better grades in math.					
12	I am motivated to learn geometry because it is required for my academic success.					
13	I often feel motivated to learn geometry when I see how it applies to real-world problems.					
14	I am able to concentrate better in geometry class than in other subjects					
15	I feel frustrated when I don't understand geometry concepts.					
16	Geometry is important for my future academic plans.					
17	I enjoy using geometry to solve practical problems in everyday life.					
18	Group activities in geometry class help motivate me to learn more.					

19	I regularly set goals to improve my geometry skills.					
20	I feel excited about learning new topics in geometry.					

Lead City University Ibadan DO NOT COPY

## Appendix IV

**Subject:** Mathematics

**Topic:** Geometry

**Sub-Topic:** Understanding Chords and Arcs in Circle

**Duration:** 40 minutes

**Class:** Senior Secondary School Two

**Mode of Lesson:** Projector or White Marker Board

**Objective:** By the end of the lesson, the students should be able to:

- i. define arc and chord of a circle
- ii. identify and label the arc and chord of a circle
- iii. understand the relationship between chords and arc
- iv. applying understanding of chord and arc to solve problem

**Textbook:** Comprehensive Mathematics for Senior Secondary School Students by D. B. Adu, Revised Edition.

**Instructional Aids:** Projector, white board, Circle diagram print out, markers and protractor

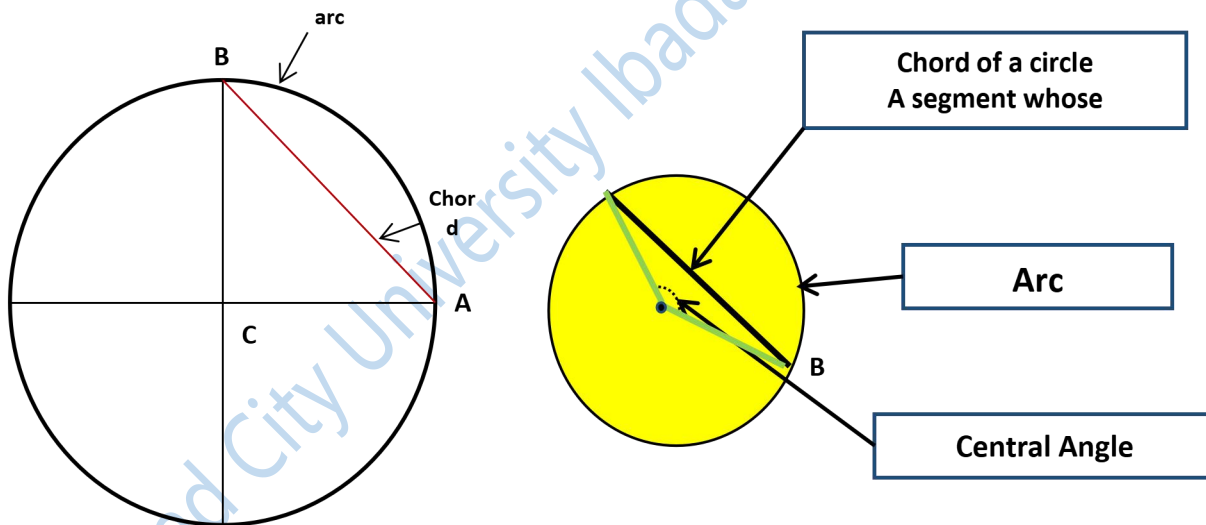
**Previous Knowledge:** The students are familiar with drawing of circles

**Introduction:** The teacher introduces the topic by defining Arc and Chord

**Step 1: Definition of Arc and Chord**

- Arc: An arc is a part of the circumference of a circle. It is the curved segment that lies between two points on the circle. Arcs can be classified as minor arcs (less than half the circumference) or major arcs (more than half the circumference).
- Chord: A chord is a straight line segment whose endpoints both lie on the circle. Essentially, it connects two points on the circumference of the circle. The longest chord in a circle is the diameter, which passes through the center.

**Step 2:** The teacher shows the student the Diagram Showing Arc and Chord of a Circle



**Step 3:** The teacher teaches the student the Formulae using in solving length of an Arc and Chord of a Circle

Length of an Arc =

$$\frac{\theta}{360} \times 2\pi r$$

**Length of a Chord** =  $2r \times \sin \frac{\theta}{2}$

**Step 4:** The students apply the formula taught in step 3 above in solving Arc and Chord related problems.

• Examples:

1. Find the length of an arc of a circle of radius 7cm which subtends an angle 84 degree at the center of the circle.
2. Find the length of a chord of circle radius 6 cm if the chord subtends angle 80 degree at the center.

**Solution to Question One**

1. Length of an Arc = :

$$\frac{\theta}{360} \times 2\pi r$$

$$\frac{84}{360} \times 2 \times 22 \times 7$$

$$\frac{84}{90} \times 11$$

$$= 10.3 \text{ cm}$$

### Solution to Question Two

- Length of a Chord =

$$\begin{aligned}2r \times \sin \frac{\theta}{2} \\&= 2 \times 6 \times \sin \frac{80}{2} \\&= 2 \times 6 \times \sin 40 \\&= 12 \times 0.6428 \\&= 7.7 \text{ cm}\end{aligned}$$

**Evaluation:** The teacher evaluates the students by asking questions on the topic thought.

#### Assignment:

1. An arc of a circle is 17.6 cm. If the angle subtended at the centre by the arc is 72 degree. Calculate the radius of the circle.
2. A chord of length 9 cm is drawn on a circle of radius 16 cm. Find the angle subtended at the center by the chord to the nearest whole number.

## **Bio- data**

### **A. Personal Data**

**Name:** Ameen Olawale MUHAMMED-RAJI

**Place Of Birth:** Akure

**Date Of Birth:** 25<sup>th</sup> September, 1975

**Nationality:** Nigerian

**State Of Origin:** Ondo State

**Local Government Area:** Akure South

**Religion:** Islam

**Permanent Address:** **House B 13**, Olosa Village, Temidire Estate Via Ojo-Ekun  
Road, Odo-Ona Elewe, Oluyole, Ibadan

**Postal Address:** P.O. Box 37165, Dugbe, Ibadan

**G.S.M. Number:** 07031531332, 07030045012

**E-Mail Address:** Bakkahschools@Gmail.Com

**Marital Status:** Married

### **B. Educational Institution Attended With Dates**

- Lead City University, Ibadan 2022 Till Date
- Federal University Of Technology, Akure 1999 – 2003
- Ondo State College Of Education, Ikere Ekiti 1994 – 1997
- Deril Computer College Of Technology, Ibadan 2002
- Akure Muslim College, Akure 1988 – 1993
- Salvation Army Primary School, Akure 1981 – 1987

### C. Academic Qualifications with Dates

- Masters of Science Degree In Mathematics Education(In view) 2022-
- Bachelor of Technology In Industrial Mathematics(2<sup>nd</sup> Class Upper Division) 2003
- National Certificate In Education (Physics, Computer Science, Education and Language And Communication Skills) 1997
- Diploma In Computer Engineering 2002
- Senior Secondary School Certificate 1994
- Primary School Leaving Certificate 1987

### D. Working Experience

- **Bakkah Schools Ibadan** 2013 - Date  
School Proprietor  
Head Of School Management Team  
Image Maker Of The School
- **Muksfar Lilies Nur/Pry School, Ibadan** 2012 – 2013  
Head Teacher  
Overseeing The Smooth Running Of The School  
Giving Weekly Report On The School Activities  
Head Of School Management Team  
Image Maker Of The School
- **Frontline College, Ibadan** 2012  
Ag. Principal And Head Of Mathematics Department  
Seeing To Day To Day Activities Of The School  
Strengthening The Interest Of Mathematics As A Course In The Mind Of The Students  
Head Of Students` Mobilizing Team  
Marking Of Teachers` Lesson Notes And Diary
- **Intercontinental Bank Plc (Marketing Unit)** 2009-2012  
Marketing Current and Savings Account
- **Beechford International High School, Ibadan** 2007-2009  
Ag. Principal and Head Of Mathematic Department  
Overseeing The Smooth Running Of The School  
Strengthening The Interest Of Mathematics As A Course In The Mind Of The Students  
Reviving Mathematics Club In The School

Taught With High Level Of Commitment And Proficiency

- **Adesina College, Ibadan** **2005-2007**  
Head Of Mathematics Department  
Taught With High Level Of Commitment And Proficiency  
Strengthening The Interest Of Mathematics As A Course In  
The Mind Of The Student
- **Akure Acedemy, Akure** **1999 - 2003**  
Part-Time Mathematics Tutor  
Taught With High Level Of Commitment And Proficiency
- **Nickdel College, Ibadan** **1997 - 1999**  
Computer Instructor

#### **E. Post Held With Dates**

- President, National Association Of Mathematics  
Student Of Nigeria (NAMSN) Futa Chapter 2002
- Chairman, Corpers`Welfare Association 2004
- Corpers` Liason Officer, Gassol Local Govt. Area 2004
- Head Of Mathematics Department 2006 - 2017
- Secretary, Association Of Model Islamic Schools,  
Oluyole Chapter 2017-2019
- Vice Coordinator Association Of Model Islamic Schools,  
Oluyole Chapter 2019-2022
- Chairman, Temidire Oloosa Landlord and Landladies  
Association 2017-2021
- Coordinator, Association of Model Islamic Schools,  
Oluyole Chapter 2022 Till Date

## **F. Research Works**

- Test of Heteroscedasticity (B. Tech Project) 2003
- Effect of Computer Assisted Instruction on Senior Secondary School Students Academic Achievement in Oluyole Local Government Area, Oyo State 2024

## **G. Extral Curricular Activities:**

Reading, Learning New Things, Travelling

## **H. Membership of Professional Organization**

Teachers Registration Council Of Nigeria (TRCN) 2013

## **I. Publication:**

A. O. MUHAMMED-RAJI & A. A. WAHEED, (2024). *Effect Of Computer Aided Instruction on Senior Secondary School Students in Geometry in Oluyole Local Government Area, Oyo State*, Advance Journal of Education and Social Sciences, 9(12), 1-11.

## **J. Referees:**

1. Dr. Fasoranbaku  
Federal University Of Technology, Akure  
08033932972

2. Dr. Waheed A.A  
Lead City University, Ibadan  
07031199441

3. Alh. Musa Muhammed-Raji  
De-Firdaus Educational Schools  
08036289334

-----  
**Signature**

-----  
**Date**

### **The University Compliance Certification**

This is to certify that this thesis by Ameen Olawale MUHAMMED-RAJI with matriculation number LCU/PG/003976 in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State is in full compliance with the approved university format and style.

-----

**Signature**

-----

**Date**

Lead City University Ibadan DO NOT COPY