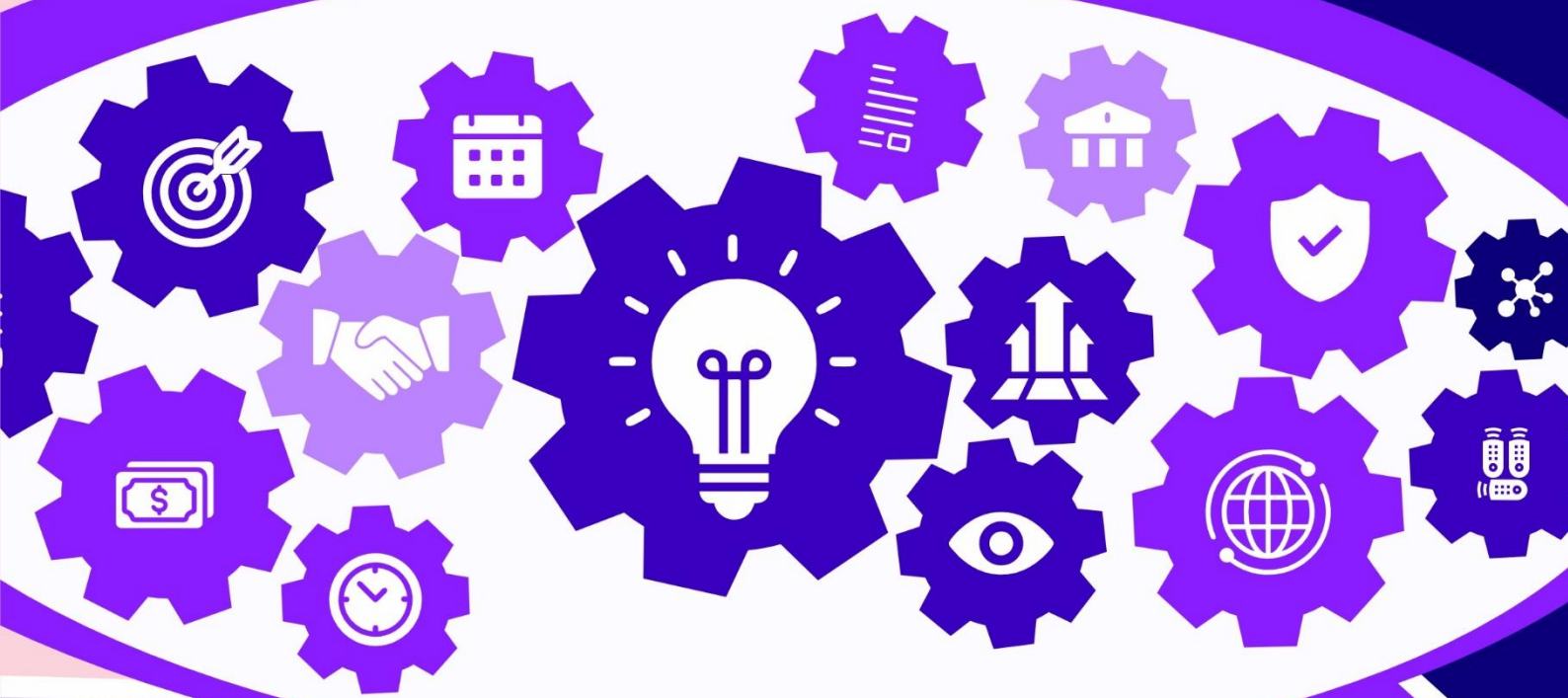


# JOURNAL OF RESEARCH IN SCIENCE EDUCATION (JORISE)



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JORISE is a double blind peer reviewed publication that covers issues of science disciplines, pedagogy, curriculum, and instruction in line with global best practices and also provides academic insights.

I appreciate all the contributors that are lucky to publish in this volume and it's my hope that researchers and students will continue to subscribe for academic engagements and research. Equally soliciting continued support for future publications.

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Thank you to all contributors, reviewers, and readers for the successful production of this edition. Their engagement strengthens science education globally, while I solicit for continued support for future production.

**O. I. Oginni Ph.D**

**Editor-in-Chief**



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# IMPACT OF ICT INTEGRATION ON REDUCING LEARNING GAPS AMONG UNDERGRADUATE STUDENTS IN THE CENTRAL SENATORIAL DISTRICT OF KOGI STATE

BY

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## Abstract

*This paper investigated the impact of ICT integration on reducing learning gaps among undergraduate students in the Central Senatorial District of Kogi State, Nigeria. In contemporary learning environments, ICT is no longer viewed merely as a supplementary instructional tool but as a central driver of pedagogical transformation capable of promoting flexibility, learner autonomy, collaboration, and inclusivity. Despite these expectations, evidence suggests that the relationship between ICT integration and learning equity is complex and highly context-dependent. The paper employed descriptive survey involving the correlation approach. 400 undergraduate students were sampled for the study. The instrument used to collect data was a questionnaire, the research questions raised were answered by using mean and standard deviation while the hypotheses formulated were tested with Pearson's product moment analysis ( $r$ ) at 0.05 level of significance. The study found out that integration of ICT lead to efficient and effective delivery of instructions. Undergraduate students who use ICT devices in their study have shown enhanced academic achievement. Therefore, the paper concludes that integration of ICT bridges learning gaps among undergraduate students thereby making teaching and learning exciting and interesting. The paper recommends among others that higher education institutions should prioritize the provision of adequate ICT facilities, including computers, reliable internet connectivity, and relevant software, to ensure that all students have equitable access to digital learning resources. This will help bridge access-related learning gaps.*

**Keywords:** Impacts, ICT Integration, Learning Gaps. Undergraduate Students

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## Introduction

In the 21st century, Information and Communication Technology (ICT) has become an indispensable element in the educational landscape, promising transformative potential for teaching and

learning processes across all levels of education. The rapid expansion of Information and Communication Technology (ICT) has significantly reshaped the landscape of higher

education worldwide, redefining how knowledge is produced, accessed, and transmitted. ICT encompasses a wide range of digital tools and platforms including computers, mobile technologies, learning management systems, and internet resources that have the capacity to facilitate interactive, flexible, and student-centered learning environments (Idowu, 2025). In contemporary learning environments, ICT is no longer viewed merely as a supplementary instructional tool but as a central driver of pedagogical transformation. Within this context, ICT integration has been widely promoted as a strategic response to persistent educational inequalities, particularly learning gaps that manifest in differential academic achievement, access to resources, and learning outcomes among students from diverse socio-economic, geographical, and educational backgrounds.

Specifically, the extent to which ICT integration can reduce learning gaps, the disparities in educational achievement and access among students differing in socio-economic status, geographical location, or prior attainment remains a critical concern. While ICT usage has been linked to positive outcomes in developed educational settings, its impact in under-resourced and developing contexts is mixed, with evidence showing that structural barriers often hinder meaningful integration (Baako, Osei & Abroampa, 2025). This complexity is further reflected in the uneven professional preparedness of educators and gaps in technological infrastructure, which can exacerbate rather than mitigate existing educational inequalities (Murithi & Yoo, 2021).

In Nigeria, higher education institutions have increasingly adopted ICT for instructional purposes, yet learning gaps persist, especially among undergraduate students in rural and peri-urban areas where access to technology and digital skills remain limited. These gaps threaten equity in learning outcomes and the realization of national educational goals that align with global digital inclusion imperatives.

The deployments of digital facilities/tools/ICT are intended to encourage global discourse among faculty

and students' members. The utilization of digital tools for course facilitation leaves much to be desired. Whereas, where digital facilities are utilized promptly and regularly, it is capable of increasing input as well as increasing productivity on the task performances of faculty and learners. It could also improve academic performance of a maturity of learners. Osah (2022) pointed out that digital education or ICT is the innovative use of digital tools and technologies during teaching and learning. The concept implies that ICT is relevant to the implementation of school curriculum.

Despite widespread advocacy for ICT integration as a strategy to enhance educational quality and equity, there remains significant variation in how ICT is implemented and its effectiveness in reducing learning disparities among undergraduate students. This is still in agreement with Osah (2022) that though the encouraging effect of age of ICT, most departments in the number of universities in some part of Nigeria are lagging behind in its application for curriculum implementation. Studies suggest that although ICT can improve engagement and access to resources, inequitable access to devices, inadequate digital literacy, and limited professional development undermine its potential impact (Idowu, 2025). In many developing country contexts, including parts of Sub-Saharan Africa, infrastructure constraints and lack of institutional support further limit meaningful ICT integration (Baako, Osei & Abroampa, 2025).

In the Central Senatorial District of Kogi State, these challenges are especially pronounced. Many higher education institutions in the area contend with inconsistent internet connectivity, inadequate digital learning facilities, and variations in lecturers' competence in integrating ICT into pedagogy. Consequently, undergraduate students experience unequal opportunities to benefit from technology-enhanced learning, reinforcing gaps in academic performance, digital literacy, and overall learning outcomes. Although national and institutional policies emphasize ICT-driven education as a pathway to quality and equity, there remains limited empirical

clarity on whether, how, and under what conditions ICT integration actually contributes to reducing learning gaps among undergraduates in such contexts. Existing studies in Nigeria have largely focused on ICT availability, utilization patterns, or general academic performance, with insufficient attention to the specific issue of learning gaps and the mechanisms through which ICT integration may mitigate or exacerbate them (Adeleke & Amoo, 2021).

Effective ICT integration can enhance learning outcomes by supporting differentiated instruction, personalized learning pathways, and continuous access to educational resources. Systematic reviews and large-scale studies demonstrate that when ICT is meaningfully embedded within pedagogy, it can improve student achievement and reduce disparities linked to prior knowledge and socio-economic status (Basri, Alandejani & Almadani, 2018). However, these benefits are contingent upon students' access to devices, reliable connectivity, and adequate digital skills, as well as lecturers' capacity to align technology use with instructional goals (Baako, Osei, & Abroampa, 2024). In Sub-Saharan Africa, studies reveal that ICT adoption often occurs at a superficial level, with limited pedagogical integration, thereby constraining its potential to address learning inequalities (Murithi & Yoo, 2021). This empirical inconsistency underscores a significant research gap concerning the effectiveness of ICT integration as a tool for reducing learning gaps in under-resourced higher education settings.

The study by Adedjoja and Abimbade (2016) found out that ICT is compatible with the implementation of school subject because it is a response to innovation in the changes taking place in the schools system. These authors reveal that current instructional deliveries favour the use of mobile tools. The findings in their study are consistent with the fact that ICT carries inherent potentials and benefits. It tools are portable, flexible, cost effective and they are easy to be put to use. Also, they have added values to the learning environment because they create excitement to learners. This is to the effect that learners' anticipation is

aroused and increased interest for learning. Thus, integration of ICT in the teaching and learning process can correlate many aspects of the objectives for introducing courses in school curriculum. One of such objectives is to keep abreast with ever changing environment. Unlike most textbooks, ICT tools are veritable source of latest information on issues.

The use of ICT models for learning in schools was investigated in the study by Udoudo and Ojo (2016) in Obia-Kpor Local Government Area of Rivers State, Nigeria. The objectives of the study were to identify the extent of use of new media and to find out challenges experienced while using new media (ICT models) for learning in schools in the Local Government Area. The study adopted survey and quasi-experiment as research design. The population of the study stood at 5,609 representing the entire population of students and heads of school studied. Sample size of 568 was used for the study. Findings showed that some of the schools were truly new media (ICT) based but under-utilized by the students in learning. The implications of the findings suggest that the knowledge and skill needed to operate ICT models such as the computer and internet browsing is lacking, thereby it affects the level of interest in the use of ICT learning tools by most students. It means that orientation and training is to be deliberately initiated in order to inspire the students towards the use of new media for learning.

Furthermore, the assumption that students' academic performance could improve when ICT devices are deployed or integrated for instructional delivery may not be unfounded. The linear correlation was reported in the study by Basri, Alandejani and Almadani (2018). The authors explore the adoption of Information Communication Technology by the universities and the impact it makes on the university students' academic performance. The study was carried out in Saudi universities. The study also examined the moderators' effect of gender, GPA and students' majors on the relationship between ICT and academic achievement. By using a

quantitative research approach and a sample of 1000 students, data were collected about the ICT adoption in universities and the relative performance of students belonging to four Saudi universities. Structured equation modeling was chosen to determine the validity of the research model. The Analysis of Moment Structures (AMOS), specially used for structural equation modeling and path analysis was used as the research tool. The findings revealed that there exists a relationship between ICT and adoption and academic performance in a conservative environment. The implication of the findings points to the fact that integration of ICT has brought about innovation to teaching and learning. It is found that integration of ICT simplify instruction, makes the learning process enjoyable, thereby stimulating cognitive ability. Hence, it could result to an improved academic achievement among undergraduate students in Kogi central senatorial district under investigation. The evidence found in several studies is further subjected to testing to find out whether the experience is the same among students in the selected samples from the investigated schools and colleges by analyzing the following parameters. Theoretically, the relationship between ICT integration and learning gaps can be understood through frameworks that emphasize access, pedagogy, and knowledge construction in digital environments. The Digital Divide Theory highlights how disparities in access to technology, skills, and meaningful usage can translate into unequal learning outcomes, suggesting that ICT may either bridge or widen learning gaps depending on contextual conditions (van, 2020). Complementing this perspective, the Technological Pedagogical and Content Knowledge (TPACK) framework posits that the educational value of ICT depends on the dynamic interaction between technological tools, pedagogical strategies, and subject content knowledge (Khan, Ameen & Rafique, 2019). From this standpoint, ICT integration can only reduce learning gaps when lecturers possess the requisite competencies to design inclusive, technology-enhanced learning experiences that accommodate diverse learners. Additionally,

constructivist and connectivist learning theories emphasize that digital technologies facilitate active, networked, and self-regulated learning, which can support equity by enabling learners to access and co-construct knowledge beyond traditional classroom constraints (Osah, 2022). Taken together, empirical and theoretical literature suggests that ICT integration holds considerable promise for reducing learning gaps in higher education, yet its effectiveness is mediated by access, pedagogical quality, and institutional support. The limited context-specific evidence from Nigerian higher education, particularly within regions such as the Central Senatorial District of Kogi State, creates a critical need for systematic investigation.

### **Purpose of the Study**

The main purpose of this study is to examine the impact of ICT integration on reducing learning gaps among undergraduate students in the Central Senatorial District of Kogi State, Nigeria. Specifically, the study seeks to:

- i. determine the extent to which ICT is integrated into teaching and learning in higher education institutions within the Central Senatorial District of Kogi State.
- ii. investigate the relationship between ICT integration and learning gaps among undergraduate students in the Central Senatorial District of Kogi State.

### **Research Questions**

The following research questions were raised to guide this study.

- i. To what extent is ICT integrated into teaching and learning in higher education institutions in the Central Senatorial District of Kogi State?
- ii. What are the existing learning gaps among undergraduate students in the Central Senatorial District of Kogi State in terms of: academic achievement, access to learning resources, and digital skills?

### **Hypotheses**

The following hypotheses were formulated to guide the study.

HO<sub>1</sub>: There is no significant relationship between CT integrated into teaching and learning in higher education institutions.

HO<sub>2</sub>: There is no significant relationship between learning gaps, academic achievement, access to learning resources and digital skills.

### Methods

This paper employed descriptive survey involving the correlation approach. This design is considered appropriate because it allows for the systematic collection of data on the level of ICT integration and the nature of learning gaps among undergraduate students, while also examining the relationships between ICT integration and learning gaps without manipulating the study variables. The target population of the study was undergraduate students in all the schools in central senatorial district of Kogi State. A multistage sampling procedure was employed for the study. In the first stage, higher education institutions in the Central Senatorial District were stratified by type (university, polytechnic, and college of education), from which a proportionate number of institutions was selected using simple random sampling. In the second stage, faculties or departments within the selected institutions was randomly chosen. In the third stage, undergraduate students were selected using stratified random sampling based on level of study and gender to ensure representativeness. Simple random sampling was used to select 400

undergraduate students; A total number of 200 students were selected at Confluence University of Science and Technology (CUSTECH) Osara, 75 students from Federal College of Education (FCE) Okene and 125 students from Okene College of Nursing Obangede. The instrument used for data collection was a self-constructed questionnaire tagged questionnaire on impact of ICT integration on reducing learning gaps among undergraduate students. The questionnaire consists of two sections, section A elicited information on demographic characteristics of the respondents and section B consisted 12 items that addressed the two formulated hypotheses. The instrument was structured based on a modified 4 point likert scale of strongly agreed, agreed, strongly disagreed and disagreed. Both generated data were further subjected to both mean calculation at 2.50 bench mark. Pearson's product moment correlation (PPMC) (r) was used at 0.05 level of significance for hypotheses testing. Findings constituted the discussion on the study.

### Results

**Research Question 1:** To what extent is ICT integrated into teaching and learning in higher education institutions in the Central Senatorial District of Kogi State?

**Table 1: Analysis of mean and standard deviation on extent of ICT integration into teaching and learning in higher education institutions in the Central Senatorial District of Kogi State**

S/N	Items	N	SA	A	D	SD	$\bar{x}$	SD	Remark
1	Lecturers frequently use ICT tools in teaching	400	130	170	60	40	2.97	0.74	Accepted
2	Course materials are accessible online or via ICT	400	150	178	48	24	3.28	0.82	Accepted
3	Lecturers incorporate interactive ICT activities	400	205	105	40	50	3.16	0.79	Accepted
4	ICT is used for submitting assignments and assessments	400	120	80	140	60	2.65	0.66	Accepted
5	I have equal access to computers, internet, and software	400	40	75	210	75	2.15	0.53	Rejected
6	I experience challenges accessing online resources	400	25	55	100	220	1.71	0.42	Rejected

$\bar{x} \geq 2.50$  Accepted otherwise Rejected

Table 1 presents result on the variable of extent of ICT integration into teaching and learning in higher education institutions in the Central Senatorial District of Kogi State. Six items were measured using the mean score statistics to determine the extent of ICT integration into teaching and learning in higher education. Results indicate that four of the items passed the benchmark of 2.5. These are; lecturers use of ICT tools (mean=2.97, SD=0.74); whether course materials are accessible online or via ICT (mean=3.28, SD=0.82); lecturers

incorporate interactive ICT activities(mean=3.16, SD=0.79); ICT is used for submitting assignments (mean=2.65, SD=0.66); while the rest two items fall short of the benchmark, which shows the extent to which ICT is integrated into teaching and learning in higher education institutions in the Central Senatorial District of Kogi State. **Research Question 2:** What are the existing learning gaps among undergraduate students in the Central Senatorial District of Kogi State in terms of: academic achievement, access to learning resources, and digital skills?

**Table 2: Analysis of mean and standard deviation on the existing learning gaps among undergraduate students in the Central Senatorial District of Kogi State in terms of: academic achievement, access to learning resources, and digital skills**

S/N	Items	N	SA	A	D	SD	X	SD	Remark
1	Institution provides adequate ICT support	400	20	28	300	52	2.04	0.51	Rejected
2	I can effectively use LMS or educational software	400	250	80	30	40	3.35	0.83	Accepted
3	My ICT skills enable me to achieve outcomes like peers	400	300	50	30	20	3.37	0.89	Accepted
4	ICT use improves my academic performance	400	50	100	150	100	2.25	0.56	Accepted
5	Some students perform better due to ICT access or skills	400	10	30	280	30	1.80	0.53	Rejected
6	ICT integration has helped reduce differences in performance	400	80	40	200	80	2.30	0.57	Rejected

$\bar{x} \geq 2.50$  Accepted otherwise Rejected

Table 2 shows that the variable dealing on the existing learning gaps among undergraduate students in the Central Senatorial District of Kogi State in terms of: academic achievement, access to learning resources, and digital skills. Based on the mean aggregate, it was observed that effective use LMS or educational software (mean=3.35, SD=0.83), ICT skills (mean=3.37, SD=0.89) and ICT use improves academic performance (mean=2.25, SD=0.56) respectively. The result implies that other items such as adequate ICT

support, ICT access or skills and ICT integration has helped reduce differences in performance. This result has answered the question on existing learning gaps among undergraduate students in the Central Senatorial District of Kogi State in terms of: academic achievement, access to learning resources, and digital skills. However, further testing is carried on the hypotheses of the study to determine the coefficient of the existing relation between variables.

**Hypotheses 1:** There is no significant relationship between ICT integration into teaching and learning in higher education institutions.

**Table 3: Analysis of PPMC (r) of ICT integration into teaching and learning in higher education institutions**

Variables	N	df	Cal R	Crit R	Level of sig.	Decision
ICT integration Learning in higher institution	400	398	0.56	.195	0.05	Rejected

N=400, df=398,  $p \leq 0.05$  Level of significance

The tested null hypotheses in Table 3 produced a significant relationship between the variables of ICT integration into teaching and learning in higher education institutions. The implication of this result indicates that course materials are accessible online or via ICT, lecturers incorporate interactive ICT activities and

ICT is used for submitting assignments helps greatly at increasing academic achievement of students. This finding is further discussed in the study.

**Hypotheses 2:** There is no significant relationship between learning gaps, academic achievement, access to learning resources and digital skills.

**Table 4: Analysis of PPMC (r) of learning gaps and academic achievement, access to learning resources, and digital skills**

Variables	N	df	Cal R	Crit R	Level of sig.	Decision
Learning gaps	400	398	0.74	.195	0.05	Rejected
						access to learning resources

N=400, df=398,  $p \leq 0.05$  Level of significance

The result of analysis on the stated null hypotheses was rejected, meaning there is a significant relationship between the variable of learning gaps, academic achievement, access to learning resources, and digital skills. The result is significant at N=400, df=398, calculated  $R=0.74$  higher than 0.05 level on the critical table value at .195 respectively. The result connotes that learning gaps, academic achievement, access to learning resources, and digital skills are significant at bridging the gap of inadequacies in teaching and learning but also enhance students academic achievement. This finding is further discussed in literature sought for the study.

#### Discussions

The study set out to examine the impact of ICT integration on reducing learning gaps among undergraduate students in the Central Senatorial District of Kogi State. The findings reveal several notable patterns regarding both ICT integration and the nature of learning gaps.

First, regarding the extent of ICT integration in teaching and learning, the results indicate a moderate level of ICT use across the surveyed institutions. Mean scores for items measuring ICT integration (Q1-Q4) ranged from 3.28 to 2.65, suggesting that lecturers incorporate ICT tools into instruction, but not consistently or comprehensively. Specifically, the frequent use of ICT tools, accessibility of online materials, and interactive ICT activities were moderate, indicating that while ICT is present, it may not yet be fully embedded into pedagogical practices. These findings align with previous studies in developing country contexts, which reported that although ICT is introduced in higher education, infrastructural limitations and insufficient lecturer training often hinder its full potential (Murithi & Yoo, 2021; Baako, Osei, & Abroampa, 2024). The results also support the TPACK framework (Khan, Ameen & Rafique, 2019) which emphasizes that effective

ICT integration requires not only technology availability but also the alignment of pedagogical and content knowledge, an area where moderate adoption suggests partial implementation. Second, concerning the nature of learning gaps, the study revealed that gaps in access, skills, and academic outcomes still persist among undergraduate students. Items measuring access to ICT facilities (Q1, Q5 and Q6) showed moderate means, indicating that not all students enjoy equitable access to computers, internet connectivity, or software resources. Similarly, digital skills (Q2–Q4) were moderately high, suggesting that students possess some competence in using ICT tools. These observations are consistent with empirical evidence from other developing countries, which indicates that unequal access to ICT, infrastructural deficits, and varying levels of digital literacy continue to influence student achievement (Ahmed et al., 2021). Again, the findings agreed with the study of Basri, Alandejani and almadani (2018). The authors whose investigation focuses on ICT adoption impact on academic performance found out that there exists a relationship between adoption and academic performance in a conservative environment. In addition, the authors found that the adoption of digital devices (ICT) resulted in the improvement of students (male and female) performance in test scores. The implication of the findings is that students' use of personal ICT devices correlates their performances. Therefore, it is important for lecturers to integrate the use of personal ICT tools to bridge the gap among undergraduate students at all levels of education in our higher institutions. Hence, misuse of ICT devices such as time wasting, social media chat, pornography and other immoral acts should be discouraged.

### **Conclusion**

The study examined the impact of ICT integration on reducing learning gaps among undergraduate students in the Central Senatorial District of Kogi State. The findings indicate that while ICT is moderately integrated into teaching and learning, its use is neither uniform nor fully optimized across institutions. Students' access to ICT facilities, digital

skills, and engagement with technology were found to influence their academic performance and the degree to which learning gaps can be mitigated. Although ICT has a partial positive effect in reducing disparities in academic outcomes, persistent gaps in infrastructure, institutional support, and pedagogical practices limit its effectiveness. The study further shows that equitable access to technology, combined with adequate training for both students and lecturers, and is crucial for realizing the potential of ICT to foster learning equity. In essence, ICT is a powerful tool with the potential to narrow learning gaps, but its impact is conditional on contextual and structural factors. Without deliberate policies and interventions to ensure access, support, and skill development, ICT integration alone is insufficient to achieve substantial reductions in learning disparities among undergraduate students. The study underscores the importance of a holistic approach that integrates technological resources, pedagogical competence, and institutional support to enhance academic outcomes and promote equity in higher education.

### **Recommendations**

The paper recommends that higher education institutions in the Central Senatorial District of Kogi State should invest in upgrading ICT infrastructure, including reliable internet connectivity, functional computer laboratories, stable electricity supply, and access to licensed educational software. Since the findings show uneven and moderate ICT integration, improving infrastructure is foundational to achieving equitable learning opportunities. Also, institutional management should implement policies that guarantee equal access to ICT resources for all students, regardless of department, socio-economic background, or level of study. This may include extended laboratory hours, subsidized internet access, device loan schemes, or student technology grants to reduce access-related learning gaps. Again, regular training workshops should be organized to enhance lecturers' capacity to integrate ICT effectively into pedagogy. Emphasis should be placed on instructional design, interactive digital

tools, online assessment strategies, and inclusive technology practices. Since ICT use was found to be moderate and not fully optimized, pedagogical competence must be strengthened.

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## CORRELATION BETWEEN AFFECTIVE VARIABLES AND STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS IN SOUTHWESTERN UNIVERSITIES, NIGERIA

BY

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### Abstract

*This study examined the inter-relationships between affective variables and performance in Mathematics of Southwestern Nigerian Universities students. A total of 755 male and female students, purposively selected from seven departments were involved in the study. Three instruments were employed namely: Mathematics Self-concept Scale ( $r = 0.63$ ), Mathematics Self-efficacy Scale ( $r = 0.79$ ) and Mathematics Anxiety Scale ( $r = 0.82$ ). Students' performance in mathematics (PIM) was determined by the average scores obtained in their mathematics courses. Using linear regression, the results revealed that, for both male and female students, Mathematics self-concept (MSC) and Mathematics self-efficacy (MSE) had a significant joint effect on PIM. However, only MSE demonstrated a significant relative effort on PIM. The results also showed that both Mathematics anxiety (MAX) and Mathematics self-efficacy (MSE) have significant joint effect on PIM and that only MSE also has relative effort on PIM. It is, therefore, suggested that affective variables should be considered along with other factors of performance in Mathematics in our attempt to improve upon university students' performance in Mathematics.*

**Key words:** Sex, Self-concept, Self-efficacy, Anxiety and Performance in Mathematics (PIM)

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### Introduction

Mathematics is a vital subject, essential in our daily lives and taught in all academic institutions all over the world; kindergartens, primary schools, secondary schools, pre-university colleges as well as at higher institutions. Mathematics, according to Adeyinka, Adeniyi, and Oyediji (2020), is a subject that significantly impacts various aspects of human life, influencing them to differing degrees. At higher levels of education, mathematics serves as a fundamental requirement for most programs of study. Moreover, mastering mathematical skills serves as a crucial indicator of a student's potential for

success across all levels of academic pursuit.

Despite the crucial role of mathematics as a prerequisite for success in various fields of study (Ogunniyi & Okereke, 2020) and its significant impact on individuals' daily lives, problem-solving skills, and critical thinking (Nicol & Crespo, 2018), mathematics remains a challenging subject for many students. Furthermore, students' aversion to mathematics often produces a spill-over effect, negatively impacting their learning in other subjects that depend heavily on mathematical concepts (Ogunkola, 2020; Ige, 2022). Previous studies (Ugwu & Onyije, 2020; Adeyemi & Afolabi,

2019), have highlighted several student-related factors such as gender, mathematics self-efficacy, mathematics self-concept, and math anxiety - that significantly influence students' performance in the subject.

The development of every nation depends on the active participation of its citizens, both males and females. Equipping both sexes for effective contribution to the nation's development is therefore very much important in our educational setting. It is believed that people can manage their personal life as well as professional duties when they are well educated, and mathematics as a subject has proved itself an indispensable tool for the development of a person and the nation as a whole. This has made mathematics receive a lot of recognition in many parts of the world. As a result, many researchers and stakeholders have developed a growing interest in finding out students' performances in mathematics due to its importance within and across the educational curricula. Although research suggests that gender differences in mathematics learning are unclear during elementary school years, studies indicate that boys tend to outperform girls in mathematics during intermediate school years, a trend that persists into high school (Lavy & Sand, 2018).

A study by Oyediran, Oyediran and Ajibade (2022) investigate the expectations of male and female students in undergraduate mathematics courses in Nigerian universities. The results show no significant difference in confidence levels between males and females regarding completing their bachelor's program. However, females expressed lower confidence than males in pursuing master's or doctoral degrees. Research also highlights the disparity in confidence levels between females and males, even among those with similar confidence levels (Afolabi, 2020). Furthermore, a study by Adejumo (2019) finds that female students in Nigerian universities were more likely to switch from mathematics-related majors to non-mathematics fields.

Sex-differences in perceived usefulness of mathematics are often linked to the stereotype that mathematics

is a male male-dominated domain. This stereotype persists in Nigerian society, where males dominate careers that heavily rely on mathematics, such as engineering, surveying, and laboratory technology (Adegoke, 2020). Furthermore, the Nigerian education system reinforces this stereotype by emphasizing the contributions of male mathematicians and scientists, such as Einstein, Newton, and Pythagoras, while overlooking the achievements of female scientists (Ogunniyi, 2017). As a result, females may avoid mathematics, perceiving it as a male-dominated field. He adds that mathematics is seen as a difficult and most feared subject by students especially females.

Research on the biological factors influencing the performance gap between male and female learners suggests differences in brain structure, hormone production, and maturation rates may contribute to variations in academic performance (Okebukola & Oyediji, 2020). Furthermore, studies have shown that the brain regions responsible for processing verbal information and facilitating inter-hemispheric communication are more developed in females (Adebesin, 2019). Research suggests that girls exhibit earlier development in brain regions responsible for impulse control and emotional regulation (Adeyemo, 2023). In addition, studies have shown that the brain's structure and function differ between males and females, influencing learning and academic performance (Ogundokun, 2023).

Gender remains a widely debated variable in educational research, with conflicting findings. Some studies suggest a significant relationship between gender and mathematics performance, favouring boys (Oguntade, 2022). Research indicates that male students tend to outperform their female counterparts in science, technology, engineering, and mathematics (STEM) subjects (Afolabi, 2020). Boys often excel in numerical aptitudes, spatial reasoning, and science, while girls tend to perform better in verbal fluency, memory, and manual agility (Adeyemo, 2022). However, other studies found no significant gender-based

differences in mathematics achievement scores (Okoro, 2020; Eze, 2022).

Research has shown that gender differences exist in mathematics classes, particularly in cognitive processes related to problem-solving. A study by Oyedotun (2022) finds that girls tend to rely on memorization, while boys employ more complex problem-solving strategies. Furthermore, girls are less likely to develop the motivational characteristics necessary for achieving success in mathematics and science, especially at higher grade levels (Adeyemo, 2022). Likewise, research by Okoro (2020) indicates that girls report lower confidence than boys in their ability to perform well on mathematics tasks in the classroom. Mathematics and sciences are often perceived as masculine domains of achievement (Eze, 2022).

The issue of gender disparity in science and mathematics achievement remains a topic of investigation, even at the tertiary level of education, with no consensus yet on which group performs better. Research in Nigeria has consistently shown that women's participation and achievement in science, technology, engineering, and mathematics (STEM) fields are significantly lower than those of their male counterparts (Adeyemi, 2022). According to Ajayi (2020), factors such as societal expectations, cultural norms, and limited access to resources contribute to the low level of women's achievement in STEM fields. Furthermore, research by Okoro (2022) highlights the intersectionality of gender with other factors such as ethnicity, social class, and disability, which can heighten existing disparities in STEM education.

The study of self-concept has gained significant attention in psychological research in recent years. According to Adeyemo (2022), self-concept encompasses various dimensions, including academic and non-academic components. Academic self-concept is further divided into subject-specific self-concepts, such as mathematics and English, while non-academic self-concept includes social, emotional, and physical components (Okoro, 2020). Research by Oyedotun (2022) supports the notion that academic self-concept is a significant

predictor of academic achievement, particularly in core subjects like mathematics and English.

Self-concept plays a crucial role in social competence, influencing an individual's feelings, thoughts, learning, self-value, relationships, and behavior (Adeyemo, 2022). Research by Oyedotun (2022) highlights the motivational properties of academic self-concept, suggesting that changes in academic self-concept can lead to changes in subsequent academic achievement. Furthermore, studies by Okoro (2020) and Ajayi (2022) support the reciprocal relationship between self-concept and academic achievement, indicating that prior academic achievement affects subsequent academic self-concept, and vice versa. This suggests that a negative attitude towards a particular subject, resulting from low self-concept, can lead to decreased confidence and lower achievement in that subject.

Psychologists have paid a lot of attention to factors related to the formation and development of self-concept. This issue is very important to the field of mental health, as an individual's conception of his or her person, which is linked to the personality, to a certain extent determines the attitude of that person to his or her environment, and to a larger extent the person's academic performance. It may then be suggested that if self-concept is positive and normal, the individual will possess normal mental health. Unfavourably, if self-concept is negative and abnormal, the individual may behave abnormally in his or her environment. The implication is that good mental health (resulting from positive self-concept) makes for positive academic.

Research has consistently shown a significant correlation between self-concept and academic performance. According to Oyedotun (2022), there is a reciprocal relationship between academic self-concept and subsequent achievement, indicating that positive self-concept can enhance student achievement, while better student achievement can also improve self-concept. Similarly, Adeyemo (2022) finds that a positive self-concept is a potential

facilitator of motivation and performance, while Okoro (2020) notes that self-concept of academic ability has a positive relationship with achievement over time. Therefore, it can be deduced that the better the self-concept of academic ability, the higher the academic performance, and changes in self-concept will have a corresponding effect on academic performance.

Akomolafe and Ogunsola (2020) investigate the relationship between self-efficacy, test anxiety, and academic performance among Nigerian university students. The findings revealed that low self-perceived academic competency negatively affected students' Grade Point Average (GPA). In short, high test anxiety negatively affected self-perceived academic competency. The study also finds a positive correlation between self-perceived academic competency and academic performance. Thus, students with low self-concept tend to perform poorly academically. Oyediran et al (2022) in their study on mathematics self-efficacy and academic performance among Nigerian secondary school students show that students' personal factors, including self-efficacy, predicted their academic achievement in mathematics. According to the results obtained from this study, students' low or high performance is due to their personality factors, and the more students improved on their self-concepts, determinations, and high interest, the better their performance in mathematics.

Another study by Adejumo (2020) on the relationship between self-efficacy and mathematics achievement among Nigerian senior secondary school students reveals that students with high self-efficacy tend to achieve better in mathematics than those with low self-efficacy. Furthermore, a study by Ogunniyi et al (2020) finds that self-efficacy was a significant predictor of mathematics achievement among Nigerian secondary school students. Many students doubt their capabilities to succeed in mathematics, being one of the most dreadful subjects in schools. Mathematics, as one of the compulsory subjects in the Nigerian educational system, has been a major problem to students from primary level to higher institution. Students

believe that mathematics is meant for some selected students because they lack a sense of efficacy. They believe that they can never do well in mathematics, no matter the effort they put in. As a result, it has become a major concern within the Nigerian educational system and globally. Many students are underperforming in mathematics, largely due to low levels of self-efficacy. According to Oyediran, et al (2022), when students begin engaging with a task, they consider several personal and contextual factors, such as their perceived ability, the difficulty of the task, the amount of effort required, the available of support, and their past experiences of success or failures.

Oyediran et. al (2022) assert that self-efficacy (a student's confidence in his or her ability to overcome challenges to attain specific goals) influences how students respond. Thus, self-efficacy predicts choices students make about how to engage with tasks: a person with the same knowledge and skills may perform poorly, adequately, or extraordinarily depending on fluctuations in self-efficacy beliefs (Oyediran et. al, 2022). Ogunniyi et. al (2020) also find that higher self-efficacy appears to reassure and compose learners who face challenging tasks whereas low self-efficacy invites students to emphasize errors and other information that handicaps performance. Research indicates that students with a strong sense of academic self-efficacy profit in several ways (Ogunniyi et al, 2020). Students with a strong sense of self-efficacy seem to self-regulate more productively, more willingly take on challenging tasks, apply more effort, persist longer despite obstacles, experience less anxiety, use more effective tactics and strategies, achieve better academic performances, and cognitively process information more effectively (Ogunniyi et al, 2020).

Also, Oyediran, et al (2022) report that mathematics self-efficacy was a significantly positive predictor of mathematics achievement in Nigerian secondary schools. Their findings suggest that students who were confident of their performance in mathematics tended to have better mathematics achievement. Students who have high mathematics self-

efficacy could understand well the most difficult material presented. They could do well on mathematics assignments and tests, and, more importantly, they could master the skills being taught in their mathematics classes, hence, they were more likely to have better mathematics achievement. Therefore, there is a need to improve students' self-efficacy which may improve students' mathematics achievement.

Not all researchers have found a significant relationship between efficacy beliefs and academic outcomes. Oyedotun (2022) discovers that Nigerian college students' self-assessment of mathematical ability was a stronger predictor of academic achievement (GPA) than self-efficacy. However, self-efficacy was measured using a global self-concept scale, which may not accurately capture context-specific efficacy beliefs. Similarly, Adeyemo (2022) finds that self-efficacy was a weak predictor of academic performance among Nigerian secondary school students, possibly due to the use of a general self-efficacy scale rather than a task-specific measure. Okoro (2020) notes that when efficacy beliefs do not align with the specific task or criteria, they are unlikely to be predictive of academic outcomes

Some researchers have reported a lack of relationship between mathematics self-efficacy and mathematics performance, but these studies often suffer from important conceptual and measurement flaws. Oyedotun (2022) finds that the relationship between mathematics self-efficacy and performance was significant, but only when self-efficacy was assessed with specific, context-dependent items (e.g., "I am confident in my ability to solve this mathematics problem"). In contrast, studies that use global, general items to assess self-efficacy (e.g., "I am good at mathematics") often find no significant relationship with performance (Adeyemo, 2022). Okoro (2020) noted that the relationship between mathematics self-efficacy and performance is complex and influenced by various factors, including prior experiences, social support, and cognitive styles. Therefore, more nuanced and context-specific measures of self-efficacy are needed to fully understand

its relationship with mathematics performance.

Mathematics anxiety refers to the emotional responses and personal experiences that individuals develop towards learning mathematics. Negative feelings towards mathematics often arise from various encounters related to the presentation, teaching, and learning of mathematics (Adeyemo, 2022). According to Oyedotun (2022), mathematics anxiety is characterized by feelings of apprehension and tension that individuals experience when faced with mathematical problems. This anxiety can manifest physically, such as a rapid heartbeat, and cognitively, such as a lack of confidence in one's ability to solve mathematical problems (Okoro, 2020). Mathematics anxiety can become a debilitating condition, leading students to avoid mathematics altogether (Ajayi, 2022). In Nigerian contexts, mathematics anxiety has been found to interfere with students' ability to manipulate numbers and solve mathematical problems in various academic and everyday situations (Eze, 2022).

Mathematics anxiety is a pervasive issue affecting many individuals. Research has shown that it can have debilitating effects on college students, including feelings of nervous tension, fear of rejection, and stress (Adeyemo, 2022). According to Oyedotun (2022), mathematics anxiety can significantly impair students' performance, much like a novice golfer on the first tee, by fostering nervousness and insecurity towards mathematics. At the tertiary level, this anxiety is often most pronounced in mathematics courses required for non-technical majors (Okoro, 2020). Most mathematics educators concur that mathematics anxiety primarily stems from students' deep-seated fears of failure and feelings of inadequacy (Ajayi, 2022). Although mathematics anxiety may not always be extreme, it can persistently haunt students throughout their academic encounters with mathematics (Eze, 2022).

According to Oyedotun (2022), there are three primary causes of mathematics anxiety: beliefs, learning environment, and anticipatory response. These variables are interconnected and

reinforce one another. Beliefs may encompass negative stereotypes about one's gender, race, or ethnicity (Adeyemo, 2022). Research by Okoro (2020) suggests that cultural beliefs can contribute significantly to mathematics anxiety, particularly among female students. To address this issue, cognitive restructuring of beliefs and promoting positive self-talk can be beneficial (Ajayi, 2022).

Studies have shown that students propose various strategies to reduce mathematics anxiety. These include teachers providing study habits guidance, confidence-building measures, and hands-on activities (Eze, 2022). Also, students suggest that after-school tutoring, self-help programs, and relaxation techniques can help alleviate mathematics anxiety (Oyedotun, 2022). Teachers can also employ curricular and instructional strategies, such as retesting, self-paced learning, technology integration, and communication, to minimize mathematics anxiety (Okoro, 2020).

Mathematics anxiety has been found to impede working memory efficiency, as intrusive thoughts and worries divert focus away from mathematical tasks, leading to decreased logical thinking, increased errors, and prolonged processing times (Oyedotun, 2022). Research has shown that mathematics anxiety can have long-term consequences, including decreased competence, reduced completion rates, and lower academic performance in mathematics (Adeyemo, 2022). A study by Okoro (2020) finds a negative correlation between mathematics anxiety and performance, indicating that learners with higher levels of mathematics anxiety tend to have lower levels of performance in mathematics.

In Nigeria, mathematics education is crucial for national development and global competitiveness. However, mathematics anxiety remains a significant challenge, particularly among non-mathematics majors (Eze, 2022). Research has identified various factors contributing to poor performance in mathematics, including institution-related variables, teacher-related variables, home-related variables, and student-related variables (Ajayi, 2022).

Other available literatures have related students' inability to apply mathematics concepts, principles and skills in their respective courses of study to variables such as sex, self-concept, self-efficacy, and anxiety. As a result of these factors, this study, sought to investigate the extent to which students' sex, self-concept, self-efficacy and anxiety determine the performance of Non-mathematics majors in Southwestern Nigerian Universities. The outcome of this study with respect to the selected variable will significantly serve as a pointer to other future researchers. In the same way, the study provides knowledge and guidelines that may be of help to students, mathematics teachers/lecturers, parents, policy makers and the entire society at large in improving the above-mentioned students' mathematics performance. This will also serve as an insight for educational authorities in the country for better decision. More importantly, this study differs from related studies.

### **Hypotheses**

The following research hypotheses were tested at 0.05 level of significance

H01: There is no significant joint and relative effect of self-concept and self-efficacy on performance of students in Mathematics in Southwestern Nigerian Universities.

H02: There is no significant joint and relative effect of self-concept and self-efficacy on performance of students in Mathematics based on gender in Southwestern Nigerian Universities.

H03: There is no significant joint and relative effect of self-efficacy and anxiety on performance of students in Mathematics in Southwestern Nigerian Universities.

H04: There is no significant joint and relative effect of self-efficacy and anxiety on performance of students in Mathematics based on gender in Southwestern Nigerian Universities.

### **Procedures**

The study adopted ex-post facto research design. The population of the study consisted of all the final year students enrolled in Mathematics-related

courses in Universities located in Southwestern Nigerian. The sample of the study was selected using the multi-stage sampling technique. At the first stage, three states out of the six states in the Geo-political zone were selected using purposive sampling technique. At the second stage, six universities were selected based on the availability of the following seven academic programmes - Chemistry, Physics, Computer Science, Civil Engineering, Electronics/Electrical Engineering, Economics and Sociology in both the Federal and State Universities. At the third stage, final year regular undergraduate students consisting of 755 respondents altogether were selected using simple random sampling technique. In order to collect data and provide answers to the research hypotheses, the following instruments were developed and employed in gathering the data:

1. Student Biographic Data (SBGD): SBGD was used to elicit information on the biographical data of students on questions such as Name of Institution, Students' registration number, Level, Courses of study, Sex, Age and Grade scales obtained in WAEC/NECO used for gaining admission into their current institution
2. Mathematics Self-concept Scale (MSCS): MSCS was an adapted 14-items from Wigfield and Eccles (2000) used to elicit information among others on a) how good the participants think they are at Mathematics, b) how well they expect to do in the future in Mathematics, c) how good they will be at learning something new in Mathematics
3. Mathematics Self-efficacy Scale (MSES): MSES was an adopted 7-item from Midgley, Maehr, Hruda et al (2000) to elicit information on participants' belief or confidence in his ability to do Mathematics.
4. Mathematics Anxiety Questionnaire (MAQ): MAQ was an adapted 21-item from Fennema and Sherman (1977). This was used to elicit

information on students' experience of anxiety in Mathematics.

The initial draft of the instruments was validated by giving them to experts in questionnaire and content construction for inputs. Thereafter, the items were modified along the lines suggested by the comments of these experts. Pilot testing of the instruments was also carried out by administering the instruments to fifty-four (54) students in the seven (7) selected Mathematics-related programmes in a University within the geo-political zone different from those selected for the study. The data collected showed that the students did not have problems responding to the items in the questionnaire.

Guttman Split-half method was used to determine the reliability coefficients of the instruments. The scores for each item were encoded in STATA version 12 software. The Reliability coefficients of the instruments established as: MSCS = 0.63; MSES = 0.79 and MAQ = 0.82. The construct, content and criterion related validities were found to be adequate.

The data for the study were collected from students of selected universities in the Southwestern Nigeria. After data collection, any questionnaire response that could not match with a corresponding registration number in the students Mathematics course score sheets, as obtained from the record offices of their respective institutions was discarded. The idea was to have complete sets of the students' related instruments. 930 copies of the questionnaire were distributed to the selected students doing the 7 selected programmes in the selected 6 universities of the three selected states and a total of 755 questionnaires, fully responded to, were utilized. Data collected were analyzed using linear regression at 0.05 level of significance.

## Results

**H<sub>01</sub>:** There is no significant joint and relative effect of students' self-concept and self-efficacy on performance in Mathematics of undergraduates in Southwestern Nigerian Universities

**Table 1:** Joint and Relative Effects of Self-Concept (MSC) and Self-Efficacy (MSE) on Performance in Mathematics (PIM)

R <sup>2</sup>	Adjusted R <sup>2</sup>	F	p-value	PIM	Standardized coefficient	T	p-value
0.051	0.048	20.15	0.000	MSC	-0.0811	-1.83	0.068
				MSE	0.1624	6.22	0.000

**H<sub>02</sub>:** There is no significant joint and relative effect of students' self-concept and self-efficacy on performance in

Mathematics of undergraduates based on gender in Southwestern Nigerian Universities

**Table 2:** Joint and Relative Effects of Self-Concept (MSC) and Self-Efficacy (MSE) on Performance in Mathematics (PIM) based on Gender

Sex/N	R <sup>2</sup>	Adjusted R <sup>2</sup>	F	p-value	PIM	Standardized coefficient	T	p-value
Male/493	0.049	0.046	12.73	0.00	MSC	-0.0349	-0.69	0.489
					MSE	0.2366	4.72	0.000
Female/262	0.051	0.043	6.93	0.001	MSC	-0.1352	-1.97	0.50
					MSE	0.2557	3.72	0.000

**H<sub>03</sub>:** There is no significant joint and relative effect of Mathematics self-efficacy and Mathematics anxiety on performance

in Mathematics of undergraduates in Southwestern Nigerian Universities

**Table 3:** Joint and Relative Effects of Self-Efficacy (MSE) and Mathematics-Anxiety (MAX) on Performance of Students in Mathematics (PIM)

R <sup>2</sup>	Adjusted R <sup>2</sup>	F	p-value	PIM	Standardized coefficient	T	p-value
0.068	0.065	27.31	0.000	MAX	-0.1458	-4.12	0.000
				MSE	0.2022	5.72	0.000

**H<sub>04</sub>:** There is no significant joint and relative effect of Mathematics self-efficacy and anxiety on performance in Mathematics of undergraduates based on gender in Southwestern Nigerian Universities

**Table 4:** Joint and Relative Effect of Mathematics self-efficacy (MSE) and anxiety (MAX) on performance of students in Mathematics (PIM) based on gender

Sex/N	R <sup>2</sup>	Adjusted R <sup>2</sup>	F	p-value	PIM	Standardized coefficient	T	p-value
Male/493	0.057	0.053	14.83	0.000	MSE	0.1307	4.47	0.000
					MAX	-0.0931	-2.12	0.035
Female/262	0.076	0.069	10.59	0.000	MSE	0.1325	3.50	0.001
					MAX	-0.1517	-3.30	0.001

**Discussion of findings**

In this study, the relationships among affective variable and performance of Nigerian undergraduate students as well as the influence of gender towards the selected variables and performance in Mathematics of the students were investigated. The result in table 1 revealed that R-value (0.051) has an

adjusted R<sup>2</sup> (0.048,  $p < 0.05$ ) in which both MSC and MSE accounted for 5.10% of the total variance in PIM. The F-value (20.15) which is significant at 0.05 ( $p < 0.05$ ) with beta values -0.0811 for MSC and 0.1624 for MSE showed that MSC and MSE have significant joint effect on PIM. There is

an indication that a unit increase in student's MSC will lead to -0.0811 units decrease in PIM and a unit increase in student's MSE will lead to 0.1624 units increase in PIM. This showed that student's MSC and MSE have significant relative effects on PIM. Therefore, the null hypothesis that there is no significant joint and relative effect of MSC and MSE on PIM is rejected.

From table 2, the R-value (0.049) has an adjusted  $R^2$  (0.046,  $p < 0.05$ ) in which both MSC and MSE accounted for 4.60% of the total variance in the performance of male students in Mathematics. The F-value (12.73) which is significant at 0.05 ( $p < 0.05$ ) with beta values -0.0349 for MSC and 0.2366 for MSE showed that male students' Mathematics self-concept and Mathematics self-efficacy have significant joint effect on PIM. There is an indication that for male students, a unit increase in student's MSC will lead to -0.0349 units decrease in PIM and a unit increase in student's MSE will lead to 0.2366 units increase in PIM. This showed that student's MSC and MSE have significant relative effects on PIM. In the same way, the table also revealed that R-value (0.05) has an adjusted  $R^2$  (0.05,  $p < 0.05$ ) in which both MSC and MSE accounted for 4.30% of the total variance in the performance of female students in Mathematics. The F-value (6.93) which is significant at 0.05 ( $p < 0.05$ ) with beta values -0.1352 for MSC and 0.2557 for MSE showed that female students' mathematics self-concept and mathematics self-efficacy have significant joint effect on performance in mathematics. There is an indication that for female students, a unit increase in student's MSC will lead to -0.1352 units decrease in PIM and a unit increase in student's MSE will lead to 0.2557 units increase in PIM. This showed that student's MSC and MSE have significant relative effects on PIM. Therefore, the null hypothesis that there is no significant joint and relative effect of self-concept and self-efficacy on performance of male and female students in Mathematics is rejected.

From table 3, it was revealed that R-value (0.068) has an adjusted  $R^2$

(0.065,  $p < 0.05$ ) in which both MSE and MAX accounted for 6.50% of the total variance in PIM. The F-value (27.31) which is significant at 0.05 ( $p < 0.05$ ) with beta values 0.2022 for MSE and -0.1458 for MAX showed that MSE and MAX have significant joint effect on PIM. There is an indication that a unit increase in MSE will lead to 0.2022 units increase in PIM and a unit increase in student's MAX will lead to -0.1458 units decrease in PIM. This showed that the MSE and MAX have significant relative effects on PIM. Therefore, the null hypothesis that there is no significant joint and relative effect of MAX and MSE on PIM is rejected.

From table 4, the R-value (0.057) has an adjusted  $R^2$  (0.053,  $p < 0.05$ ) in which both MSE and MAX accounted for 5.70% of the total variance in the performance of male students in Mathematics. The F-value (14.83) which is significant at 0.05 ( $p < 0.05$ ) with beta values -0.1307 for MSE and -0.0931 for MAX showed that male students' mathematics self-efficacy and mathematics anxiety have significant joint effect on PIM. There is an indication that for male students, a unit increase in student's MSE will lead to 0.1307 units increase in PIM and a unit increase in student's MAX will lead to -0.0931 units decrease in PIM. This showed that student's MSE and MAX have significant relative effects on PIM. In the same way, the table also revealed that R-value (0.076) has an adjusted  $R^2$  (0.069,  $p < 0.05$ ) in which both MSE and MAX accounted for 7.60% of the total variance in the performance of female students in Mathematics. The F-value (10.59) which is significant at 0.05 ( $p < 0.05$ ) with beta values 0.1325 for MSE and -0.1517 for MAX showed that female students' Mathematics self-efficacy and Mathematics anxiety have significant joint effect on performance in Mathematics. There is an indication that for female students, a unit increase in student's MSE will lead to 0.1325 units increase in PIM and a unit increase in student's MAX will lead to -0.1517 units decrease in PIM. This showed that student's MSE and MAX have significant relative effects on PIM. Therefore, the

null hypothesis that there is no significant joint and relative effect of students MSE and MAX on performance of male and female students in mathematics is then rejected. Notwithstanding, it is expected from theoretical viewpoint, that high and positive self-concept should match high performance in mathematics which is slightly lacking in the study.

### Conclusions

Based on the findings of this study, it could be concluded that student's MSC and MSE have significant joint and relative effects on PIM, MSC and MSE have significant joint and relative effects on male and female PIM, MSE and MAX have significant joint and relative effects on PIM, and MSE and MAX have significant joint and relative effects on male and female PIM.

### Recommendations

It is therefore recommended that:

- (i) educators should design programs to improve students' MSC and MSE, as these variables have significant joint and relative effects on performance in mathematics (PIM).
- (ii) educators should identify strategies to reduce MAX, as it has a significant negative impact on PIM.
- (iii) educators should recognize the differences in MSC, MSE, and MAX between male and female students and adapt their teaching methods accordingly.
- (iv) educators should incorporate practical activities and real-world examples to make mathematics more engaging and relevant, potentially enhancing MSC and MSE.
- (v) educators should encourage students to view challenges as opportunities for growth, rather than threats to their ego, to promote a positive MSC and MSE.

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## AVAILABILITY AND USABILITY OF INSTRUCTIONAL MATERIALS IN TEACHING AND LEARNING OF BIOLOGY IN OYE-EKITI SENIOR SECONDARY SCHOOLS

BY

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### Abstract

This study investigated the availability and usability of instructional materials in the teaching and learning of Biology in senior secondary schools in Oye Local Government Area, Ekiti State, Nigeria. Employing a descriptive survey design, data were collected from 120 Biology teachers using a validated questionnaire. Results showed that conventional instructional materials (charts, specimens, models, and microscopes) were moderately available (52.5–78.3%), while digital and technology-enhanced resources (interactive whiteboards, virtual labs, projectors) were largely unavailable (71.7–91.7%). Teachers frequently used available conventional materials (grand mean = 3.08), but usability was significantly constrained by inadequate teacher training, time constraints, overloaded syllabus, lack of electricity/internet, and poor administrative support (grand mean = 3.14). The study concludes that limited availability and low usability of modern instructional materials undermine effective Biology instruction. Recommendations include sustained teacher training, infrastructure upgrade, curriculum review, and targeted procurement of both conventional and digital resources.

**Keywords:** Instructional materials; Availability; Usability; Teacher competency; Digital resource

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### Introduction

Biology, as a basic science discipline, occupies a strategic position in the senior secondary education curriculum in Nigeria. According to the Nigerian Educational Research and Development Council (NERDC, 2018), it is clear that Biology needs to instill in learners the capacity to observe, classify, hypothesise, experiment, and make valid conclusions about living systems. These goals cannot be effectively attained through the lecture-only approach; they must be systematically exposed to large quantities of instructional resources that bring abstract ideas to life and are observable (Okebukola, 2021; Abidoye and Olorundare, 2023).

Instructional materials can be broadly understood as all resources, whether physical or digital, that can be used to transfer knowledge, skills, and attitudes through addressing the sense of multiple senses (Eze and Akudolu, 2023). They include simple, locally fabricated materials (charts, preserved samples, models) and complex electronic devices (virtual labs, PhET simulations, AR applications, and interactive whiteboards). This is due to the fact that when properly chosen and strategically used, these materials are beneficial in terms of conceptual knowledge, learning, motivation, critical thinking, and abilities (Gambari et al., 2024; Oladejo and Adesina, 2022).

Irrespective of policy announcements and decades of educational reforms, acute shortages and under-use of instructional materials in Nigerian secondary schools, especially in rural and semi-urban schools continue to be recorded in empirical studies (Afolabi and Akinyemi, 2022; Owolabi and Adedayo, 2024). Its effects are far-reaching: systemic underachievement in Biology during the West African Senior School Certificate Examination (WASSCE) and National Examinations Council (NECO) (WAEC Chief Examiners Reports, 2020-2024), low participation in science-related tertiary programmes, and the end result: a diminished national potential of scientific and technological progress. The initial informal discussions with principals and teachers in the study environment showed that most schools have a microscope that is either old or out of service, lack operational projector, and none has access to virtual laboratories. Teachers tend to use the talk and chalk pedagogy and students find it difficult to deal with the abstract issues such as genetics, ecology and physiology. It is on this basis that the current study aimed at delivering empirical underline information on the current state of provision and usability of instructional materials in teaching Biology and coming up with realistic and context-sensitive solutions.

### **Research Questions**

1. To what extent are instructional materials available for teaching Biology in senior secondary schools in Oye LGA?
2. How frequently do Biology teachers use the available instructional materials?
3. What factors constrain the usability of instructional materials by Biology teachers?
4. What strategies can enhance the effective utilization of instructional materials in Biology classrooms?

### **Literature Review**

#### ***The Cognitive Theory of Multimedia Learning and Constructivism.***

The current review is grounded in two perspectives that are complementary, the Constructivist Learning Theory (Bruner, 1977; Vygotsky, 1978) and the Cognitive Theory of Multimedia Learning (CTML) by Mayer (Mayer, 2009). Constructivism

assumes that learners build knowledge by means of engaging with real experiences and significant stimuli. The instructional materials, especially the visual and manipulative and digital learning tools, thus serve as mediational that assists the learners to close in the gap between the abstract scientific information and real-life phenomena. CTML in its turn claims that when information is delivered in good combination of verbal and visual channels, learning is maximized, cognitive load is minimalized, and retention is maximized. The theory offers a practical approach to consider the usefulness of the traditional and digital instructional materials in Biology, which is a subject that highly depends on diagrams, microscopic structures, animation, and models. These theories combined underline that the availability of instructional resources and the pedagogical cohesion of these learning resources are the key determinants of effective learning and, thus, the conceptual framework of the current research.

#### ***Conceptualizing Instructional Materials and Usability in Biology Education***

Instructional materials can be broadly understood as materials that help the teachers to make abstract concepts concrete and more interesting to the learners (Eze & Akudolu, 2023). The modern-day classification separates traditional/print materials, audio-visual aid, and digital/interactive technologies (Abidoeye and Olorundare, 2023). Nonetheless, new research indicates that owning these materials is no longer sufficient, instead, their usability is determined by the competence of teachers, readiness of infrastructures, pedagogical focus, and the level of compliance with curriculum requirements (Fakomogbon & Adegbija, 2024). Usability in a constructivist approach includes the affordances of the material, that is, its ability to enable inquiry, manipulation, visualization, as well as the skill of the teacher to arrange the learning experiences around the material. This changes the subject of discussion to be not about availability but rather meaningful integration, which emphasizes the dynamic nature of the interaction of materials, teachers, and learners.

### ***Instructional Materials and its Impact on Learning Outcomes.***

There is a lot of evidence worldwide that shows that quality teaching materials contribute greatly to conceptual understanding, motivation, and success in Biology. Research in Africa, Europe, and North America confirms that technologically improved materials, including simulations, virtual labs, and animations, generate medium to large learning effects (effect size = 0.52-0.81) when systematically incorporated into learning (Hillmayr et al., 2020; Gambari et al., 2024). These have been found to be in line with the predictions of CTML that well-constructed multimodal content enhances cognitive processing. The use of instructional materials and student achievement is also positively correlated in local Nigerian and sub-Saharan African studies (Babalola and Alabi, 2021; Okebukola, 2021; Oladejo and Adesina, 2022). As an example, Afolabi and Akinyemi (2022) found a high correlation between the availability of materials and the learning outcomes in Biology ( $r = 0.68$ ) and Oladejo and Adesina (2022) indicated a 42-percent increase in the utilisation rates when teachers are trained on improvisation. Taken together, these results imply that instructional materials are not just facilitators of the knowledge construction of learners but are also considered crucial.

### ***Systemic and Contextual Barriers to Effective Utilization***

The adoption of instructional resources, especially digital ones, is still heterogeneous across the schools of Nigeria, although there have been documented advantages. Common barriers have been cited as the lack of proper teacher training, poor electrical power, poor networking, lack of funds, and overloaded curriculum (Adesoji and Olatunbosun, 2023; Fakomogbon and Adegbija, 2024). Such an increase in the digital divide, which is particularly pronounced in rural schools, is also found in post-COVID literature, where both devices and digital pedagogy skills are low (Bello and Oke, 2024; Eze and Akudolu, 2023). These disparities are depicted through empirical surveys. According to the study published by Owolabi and Adedayo (2024), just 38

percent of sampled schools in southwest Nigeria had functioning microscopes, and only 12 percent of them had projectors. Also, fewer than 15 percent of rural schools possess equipment that can run virtual laboratories (Bello & Oke, 2024). Such infrastructural and human capacity gaps indicate a systemic imbalance between what the curriculum requires, which focuses on inquiry and practical science, and what schools are about in reality.

Theoretically, these barriers prevent the constructivist necessity of experiential learning and the preconditions of effective multimedia processing of CTML. Therefore, the usability issue in Biology education is multidimensional, and it involves the lack of material, poor professional development, and structural limitations. Although, a number of studies show low access to digital tools or lack of competence in teachers, not many of them differentiate between traditional and digital instructional resources in rural local government areas. Additionally, the available evidence is seldom positioned to chart the influence of availability, infrastructure and the teacher's skill in combining to form practical usability. The current research fills this gap by analysing simultaneously, availability, frequency of use, constraints, as well as strategies recommended by teachers in Biology classrooms. This holistic view gives a more insight into the systemic and pedagogical dynamics influencing integration of instructional material in rural Nigerian environment.

### ***Methodology***

#### ***Research Design***

This study employed a descriptive survey design, deemed appropriate for systematically examining the availability and usability of instructional materials among Biology teachers in a natural school setting. The design enabled the collection of quantitative data reflecting teachers' perceptions, practices, and contextual constraints without manipulating existing conditions.

#### ***Population and Sampling Procedures***

The target population consisted of all Biology teachers in the 28 public senior secondary schools in Oye Local Government Area. A multi-stage sampling approach was adopted. First, ten schools

were chosen through simple random sampling to ensure equal representation across the LGA. Subsequently, twelve Biology teachers were randomly selected from each school, yielding a total sample size of 120 respondents. This sample was judged sufficient for capturing variability in instructional resource availability and utilization patterns within the context.

#### **Instrumentation**

Data were collected using a researcher-developed instrument titled the Availability and Usability of Instructional Materials in Biology Questionnaire (AUIMBQ). The questionnaire comprised 36 items organized into four thematic sections:

1. Demographic Information: capturing teacher characteristics relevant to resource use.
2. Availability Checklist: a binary (Available/Not Available) inventory of conventional and digital instructional materials.
3. Frequency of Use: a 4-point scale (Always, Often, Rarely, Never) assessing utilisation intensity.
4. Constraints and Suggested Strategies: a 4-point Likert scale assessing perceived barriers and enhancement measures.

The instrument was subjected to validation by three experts in Science Education and Measurement & Evaluation, ensuring face and content validity. Reliability testing using Cronbach's alpha yielded coefficients ranging from 0.85 to 0.89, with an

overall reliability index of 0.87, indicating strong internal consistency.

#### **Data Collection Procedure**

The researcher personally administered the AUIMBQ to participants in the selected schools. This approach facilitated immediate clarification of items, enhanced compliance, and ensured complete retrieval. All 120 questionnaires were successfully collected on the same day, resulting in a 100% return rate.

#### **Data Analysis Techniques**

Data analysis was conducted using SPSS version 27. Descriptive statistics—frequency counts, percentages, means, and standard deviations—were employed to summarize availability levels, frequency of use, perceived constraints, and suggested strategies. A mean decision benchmark of 2.50 was set on the Likert-type scales, such that values  $\geq 2.50$  were interpreted as Accepted/High, while values  $< 2.50$  were classified as Rejected/Low.

#### **Results and Discussion**

This section is concerned with the analysis and interpretation of the data gathered from respondents to investigate the availability and usability of instructional materials in teaching and learning Biology. The first section deals with demographic information of the respondents and the second section deal with respondent's opinion on the availability and usability of instructional materials in teaching and learning Biology.

#### **Demographic Information**

**Table 1**  
*Demographic Information of the Respondents*

Variable	Category	Frequency	Percentage
Gender	Male	51	42.5
	Female	69	57.5
Teaching Experience	Less than 6years	7	5.8
	5 – 10years	23	19.2
	11 – 15years	47	39.2
	Over 15years	43	35.8
<b>Total</b>		<b>120</b>	<b>100</b>

Source: Field Survey, 2025

Table 1 above showed the demographic information of the respondents who were Biology teachers in Secondary Schools. It was obtained that 42.5% of the respondents were male while 57.5% were female. This is an indication that most of the teachers who responded to the questionnaire were female. Based on the

respondents' year of teaching experience, it was obtained that 5.8% had less than 6years, 19.2% had 5 – 10years, 39.2% had 11 – 15years while 35.8% had above 15years teaching experience. This is an indication that most of the respondents had over 10years teaching experience and below. Figure 1 further explain the demographic characteristics of the respondents.

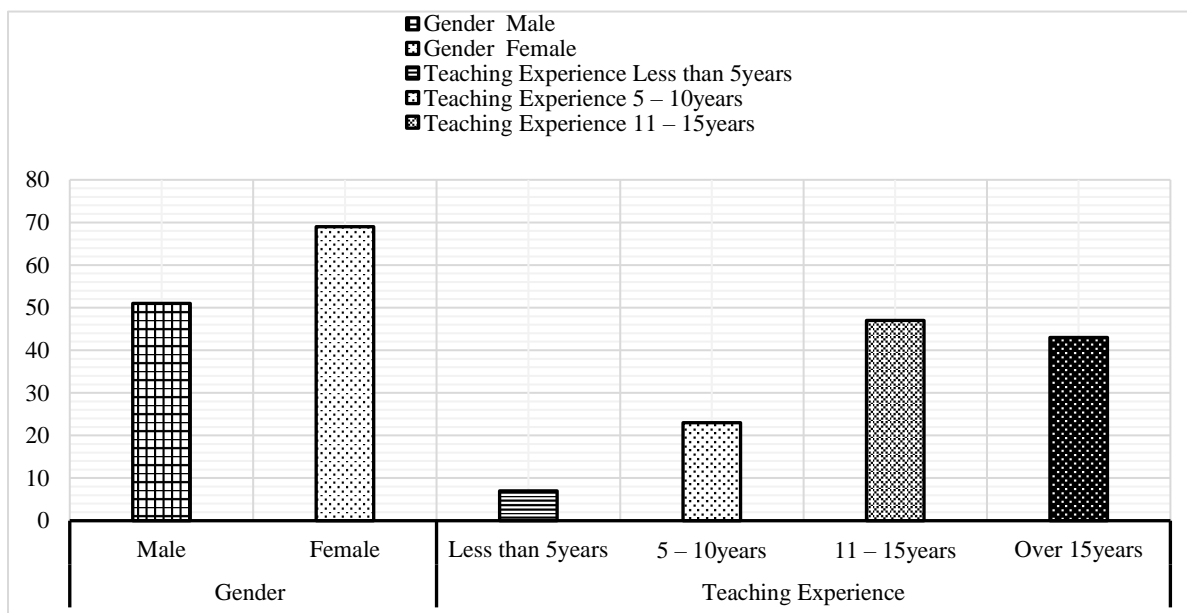


Figure 1: Demographic characteristics of the respondents

**Research Question 1: To what extent are instructional materials available for teaching Biology in senior secondary schools?**

To answer this question, respondents were asked to indicate whether various instructional materials were available in their schools. The results are presented in Table 2.

Table 2: Availability of Instructional Materials (n = 120)

Instructional Material	Available (%)	Not Available (%)
Charts/posters/diagrams	94 (78.3)	26 (21.7)
Preserved specimens	78 (65.0)	42 (35.0)
Plastic/wooden models	71 (59.2)	49 (40.8)
Compound microscopes	63 (52.5)	57 (47.5)
Dissecting kits	58 (48.3)	62 (51.7)
Projectors	34 (28.3)	86 (71.7)
Computers/laptops with internet	23 (19.2)	97 (80.8)
Interactive whiteboards	13 (10.8)	107 (89.2)
Virtual laboratory software/PhET	10 (8.3)	110 (91.7)

Findings from Table 2 show that conventional instructional materials are more available than digital ones. Charts/posters/diagrams are available in 78.3% of schools, preserved specimens

in 65%, and models in 59.2%. Microscopes are available in 52.5% of schools, while less than half have dissecting kits (48.3%). In contrast, digital and technology-based instructional

materials are largely unavailable: only 28.3% of schools have projectors, 19.2% have computers/laptops with internet, 10.8% have interactive whiteboards, and only 8.3% have virtual laboratories or simulation software.

### Research Question 2: How frequently do Biology teachers use the available instructional materials?

To address this research question, the study examined how often teachers utilised the instructional materials that were available to them. The findings are shown in Table 3.

**Table 3: Frequency of Use of Available Materials (n = 120)**

Material	Always/Often (%)	Rarely/Never (%)	Mean	SD
Charts/diagrams	86.7	13.3	3.41	0.68
Preserved specimens	72.5	27.5	3.12	0.79
Models	68.3	31.7	3.05	0.82
Microscopes	58.3	41.7	2.74	0.91
<b>Grand Mean</b>			<b>3.08</b>	

Table 3 reveals that teachers frequently use the instructional materials that are available to them. Charts/diagrams are the most used (Mean = 3.41), followed by preserved specimens (Mean = 3.12) and models (Mean = 3.05). Microscopes are used less frequently (Mean = 2.74). The grand mean of 3.08 shows that teachers generally make moderate-to-high use of the conventional materials that are present in their schools.

### Research Question 3: What factors constrain the usability of instructional materials by Biology teachers?

In response to Research Question 3, teachers rated the extent to which specific factors hindered their effective use of instructional materials. The results are presented in Table 4.

**Table 4: Constraints to Usability (Grand Mean = 3.14 > 2.50)**

Constraint	Mean	SD	Remark
Inadequate training on improvisation	3.48	0.72	High
Time constraint/overloaded syllabus	3.41	0.79	High
Lack of electricity/internet	3.36	0.81	High
Insufficient funding/maintenance	3.29	0.84	High
Lack of administrative support	3.19	0.88	High

Table 4 shows that all identified constraints recorded mean scores above the decision benchmark of 2.50. The most prominent constraint is inadequate teacher training on improvisation (Mean = 3.48). Other notable constraints include time limitations due to an overloaded syllabus (Mean = 3.41), lack of electricity and internet (Mean = 3.36), insufficient funding (Mean = 3.29), and weak administrative support (Mean = 3.19). The grand mean of 3.14 indicates

that constraints affecting usability are widespread and significant.

### Research Question 4: What strategies can enhance the effective utilization of instructional materials in Biology classrooms?

To answer this question, respondents identified strategies they believe would improve the utilization of instructional materials in Biology teaching. These findings are displayed in Table 5.

**Table 5: Suggested Strategies (Grand Mean = 3.56 > 2.50)**

Strategy	Mean	SD	Remark
Regular in-service training/workshops	3.68	0.61	Very High
Government procurement of materials	3.64	0.65	Very High
Establishment of functional Biology labs	3.59	0.69	Very High
Syllabus review to allow practical time	3.52	0.73	Very High

Table 5 indicates that all proposed strategies were strongly supported by respondents, with mean values above 3.50. Regular in-service training (Mean = 3.68) and government procurement of instructional materials (Mean = 3.64) received the highest ratings. Establishing functional Biology laboratories (Mean = 3.59) and revising the syllabus to allow adequate time for practical activities (Mean = 3.52) were also highly endorsed. The grand mean of 3.56 suggests strong teacher agreement on the need for systemic and sustainable improvements.

### Discussion

The research results indicate that there is an existing lack of balance in the provision of instructional resources in teaching Biology at senior secondary level. Traditional teaching media like charts, diagrams, preserved examples and anatomical models were found to be somewhat meticulously accessible in schools, with digital and technology-enhanced content and media being a scarcity. This is reflective of the historical record of research in Nigerian and African science education on average, with low-technology resources continuing to be the primary tool used in most of its public schools, as a result of insufficient funding and lack of infrastructure (Afolabi and Akinyemi, 2022; Owolabi and Adedayo, 2024). The close lack of projectors, computers, interactive whiteboards, and virtual laboratory software is also supportive of the idea of a digital divide as it is reflected in post-COVID literature, which focuses on the idea that rural and semi-urban learning settings remain under-equipped with ICT learning resources compared to urban centres (Eze & Akudolu, 2023; Bello and Oke, 2024).

The average access to cheap materials seems to favour the utilisation tendency of the teachers. The statistics indicate that teachers commonly resort to traditional formats like charts, models, and preserved specimens, which is consistent with the previous results that Nigerian Biology teachers tend to use the materials that are easy to obtain, inexpensive, and familiar (Oladejo and Adesina, 2022; Abidoye and Olorundare, 2023). This implies that it is not the willingness of teachers that becomes the main constraint to pedagogical innovation. Rather, the difficulty is to increase the number of resources they have at their disposal. The same conclusion has been reached in other regions in Nigeria, where the utilisation rate is quite high when the materials are available, particularly practical and visual ones (Fakomogbon and Adegbiya, 2024; Afolabi and Akinyemi, 2022).

Even with this willingness, the research also found that there exist several limitations which strongly hinder effective use of instructional materials. The most notable of these obstacles are lack of training of teachers in the field of improvisation and integrating ICT, overloaded curriculum material, electricity, and internet connectivity, insufficient funding, and lack of administrative support. These limitations are reminiscent of national and regional studies that have continued to define competency gaps in teachers and infrastructural deficiencies as the primary barriers to contemporary science education (Yusuf and Afolabi, 2025; Onwuachu and Ngozi, 2023). The teacher preparation programmes in Nigeria have been condemned over an years as having a shortfall in focus on practical exploration, digital pedagogy, as well as resource improvisation: the competencies required to effectively teach

Biology within a low-resource setting (Adesoji and Olatunbosun, 2023; Okebukola, 2021).

The salience of the electricity supply and internet supply as confining variables are also consistent with larger systemic concerns implying educational technology integration in sub-Saharan Africa. Similar results were obtained in Tanzania, Kenya, and South Africa, where researchers concluded that the inability to have reliable electricity and poor connectivity spoil the successful implementation of digital tools in the classroom (Mtebe & Raphael, 2022). This implies that this is more of a problem of functionality rather than a problem of procurement.

Moreover, the fact of limited access to the contemporary instructional material has its consequences not only regarding the classroom practice but also the conceptual knowledge of a student, his/her motivation, and future interest in the science. Studies conducted in Nigeria have repeatedly indicated that exposure to laboratory equipment, models, and simulation improve the achievement and problem-solving capacity of students, especially on abstract subjects, including genetics, ecology, and physiology (Babalola and Alabi, 2021; Afolabi and Akinyemi, 2022; Gambari et al., 2024). Thus, the lack of resources causes the continuation of superficial learning, memorisation, and low performance in national exams because of the use of talk-and-chalk teaching methods (often mentioned in the reports of WAEC Chief Examiners) (WAEC, 2020/2024).

Overall, teachers revealed that they were highly concerned with strategies that could alleviate these problems. The top-priority practices that have been identified by the respondents are engaged in continuous professional development, the governmental acquisition of instructional materials, developing Biology laboratories equipped with modern equipment, and restructuring the curriculum to gain more time to do practical tasks. Such suggestions are corroborated by the findings of studies that show the necessity of system-level changes that consider teacher capacity, infrastructure, and curriculum alignment in complementary partnership, but not individually (Okebukola, 2021; Adesoji

and Olatunbosun, 2023; Gambari et al., 2024). The multifaceted approach is also supported by international studies that show that the effects of resource provision are insignificant unless they are accompanied by instructing teacher training and the support mechanism (Hillmayr et al., 2020).

### Conclusion

The results of this research highlight the unending gaps in providing and using instructional resources effectively in teaching Biology in senior secondary schools. Although teachers have shown a willingness to deliver instruction and adopt the flexibility of employing the traditional, low-tech resources, the larger instructional context is still manifested by structural insufficiency, outdated resources, and insufficient access to the modern digitalized tools. These limitations interfere with effective interaction of inquiry-based, activity-based learning models that are the key aspect of contemporary science education.

The research points out that the means of enhancing the education of Biology is not just by increasing the availability of the material but by making long-term investments on the capacity development of the teachers, the school infrastructure, the resources in accordance with the curriculum and the support mechanisms, which can stimulate innovative teaching. Unless there are such intentional, research-based reforms, the transformative objectives of the national science curriculum of Nigeria, already expressed as scientific literacy, problem-solving, and proficiency in applied skills, will not be achieved, but may be something to look forward to. A further provision of instruction materials and complementing their integration into the pedagogical environment is thus further measures that will lead to a more equitable, engaging, and future-oriented learning of Biology among students of secondary schools.

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## EFFECTS OF MANIPULATIVE INSTRUCTIONAL MATERIALS ON SECONDARY SCHOOL STUDENTS' LOWER-ORDER THINKING IN GENETICS IN SOKOTO STATE, NIGERIA

BY

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### Abstract

The study examined the effect of manipulative instructional materials (MIMs) on secondary school students' lower-order thinking in genetics in Sokoto State, Nigeria. A quasi-experimental design involving 378 Senior Secondary School Three (SS3) biology students from four public schools was adopted. Participants were assigned to experimental and control groups. The experimental group was taught genetics using manipulative instructional materials, while the control group received instruction through conventional methods. Data were collected using the Genetics Lower-Order Thinking Test (GLOTT), a validated and reliable instrument designed to assess students' ability to recall, comprehend, and apply genetic concepts. Descriptive statistics (mean and standard deviation) and inferential statistics (independent samples t-test) were used for data analysis. Findings revealed that students exposed to manipulative instructional materials performed significantly better in lower-order thinking tasks than those taught using non-manipulative instructional materials. Results further indicated no significant gender difference among students taught with MIMs. It was concluded that manipulative instructional materials provide an effective strategy for enhancing foundational learning in genetics. The study recommends that biology teachers incorporate MIMs into instructional practice and that education authorities ensure their consistent use in teaching genetics concepts.

**Keywords:** Manipulative Instructional Materials, Lower-Order Thinking, Biology Education, Genetics

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### INTRODUCTION

Effective science education relies heavily on the availability and appropriate utilization of instructional materials that make learning meaningful and comprehensible. Instructional materials refer to all teaching aids visual, auditory, tactile, and digital—used by teachers to facilitate understanding and retention of concepts (UNESCO, 2021; Oyelekan & Bello, 2019). These materials help bridge the gap between theoretical explanations and practical experiences, thereby

enhancing learners' cognitive engagement and retention.

Instructional materials are broadly categorized into manipulative and non-manipulative types. Manipulative instructional materials (MIMs) are physical or virtual resources that students can handle, construct, or experiment with to gain hands-on experience. Examples relevant to genetics instruction include DNA and chromosome models, gene

mapping kits, and Punnett square manipulatives. These tools promote active participation by allowing learners to physically explore concepts and visualize processes that are otherwise abstract (Bello & Aminu, 2019). In contrast, non-manipulative instructional materials (NMIMs) such as chalkboards, charts, printed diagrams, and textbooks convey information passively and primarily support teacher-centered instruction. Although NMIMs assist in content delivery, they often limit learners to rote memorization rather than conceptual understanding (Arop, 2015).

In the context of Bloom's Revised Taxonomy, manipulative instructional materials (MIMs) play a crucial role in supporting the lower levels of cognitive development remembering, understanding, and applying (Anderson & Krathwohl, 2001; Krathwohl, 2022).

At the *remembering* level, students recall genetic terms, such as gene, allele, or phenotype, by associating them with tangible models. At the *understanding* level, they explain concepts like Mendelian inheritance using Punnett squares or physical models. At the *application* level, they use these materials to predict genetic outcomes and apply learned principles to simple genetic crosses. Through these processes, MIMs help solidify foundational knowledge that is essential for advancing to higher cognitive levels in subsequent learning stages.

Genetics, a core unit of the secondary school biology curriculum, focuses on the study of heredity and variation. It introduces learners to basic concepts such as genes, chromosomes, alleles, genotypes, and phenotypes, as well as to simple Mendelian principles. Mastery of these fundamental concepts requires strong lower-order thinking skills (LOTS), which enable students to recall facts, comprehend processes, and apply learned rules to basic inheritance patterns. Unfortunately, reports from the West African Examinations Council (WAEC, 2015–2021) and the National Examinations Council (NECO, 2010–2015) reveal persistent weaknesses among Nigerian students in recalling definitions, explaining genetic terms, and

solving monohybrid crosses—tasks that reflect deficiencies in lower-order thinking.

The use of manipulative instructional materials offers a promising approach to addressing these challenges. MIMs allow students to see, touch, and manipulate representations of genetic components, thereby making abstract concepts concrete. Such interaction enhances memory retention, comprehension, and conceptual application (Moyer-Packenham & Westenskow, 2019).

Furthermore, MIMs support differentiated learning by engaging students of diverse abilities and interests, fostering both motivation and inclusivity. Conversely, the continued reliance on NMIMs, such as chalkboard illustrations and textbook reading, restricts learners to passive observation, limiting their ability to recall and apply knowledge meaningfully (Bada & Olusegun, 2015). Despite evidence suggesting that MIMs can strengthen foundational learning, their application in Nigerian classrooms remains limited due to inadequate teacher preparation, lack of materials, and insufficient emphasis in biology curricula. Moreover, few empirical studies have examined their specific impact on students' lower-order thinking in genetics, particularly in northern Nigeria. Addressing this gap is essential to improving students' understanding of basic genetics concepts and to building the cognitive foundation necessary for higher-level reasoning in science.

This study therefore investigates the effect of manipulative instructional materials on secondary school students' lower-order thinking skills (LOTS) in genetics in Sokoto State, Nigeria, with gender also considered as a variable of interest.

### Statement of the Problem

Performance reports from the West African Examinations Council (WAEC, 2015–2021) and the National Examinations Council (NECO, 2010–2015) have persistently shown that Nigerian secondary school students exhibit poor achievement in genetics, particularly in questions requiring the recall, comprehension, and application of basic concepts. Many students are unable

to correctly define genetic terms, explain Mendelian laws, or apply the principles of inheritance to solve simple monohybrid and dihybrid cross problems. These deficiencies reflect weaknesses in lower-order thinking skills (LOTS), which are foundational to deeper understanding and problem-solving in science. When students fail to master LOTS, they struggle to progress to higher-order thinking tasks such as analysis, evaluation, and synthesis.

The problem is further compounded by the predominant reliance on non-manipulative instructional materials (NMIMs) including textbooks, chalkboards, and static charts which emphasize teacher-centered instruction. These materials, while adequate for content presentation, rarely provide opportunities for learners to actively engage with content or construct their own understanding. Consequently, learning remains largely passive, emphasizing rote memorization over comprehension and application. This situation limits students' ability to transfer knowledge or relate classroom experiences to real-life biological phenomena.

By contrast, manipulative instructional materials (MIMs) such as chromosome models, Punnett square kits, and gene interaction boards offer learners hands-on opportunities to observe, experiment, and visualize abstract genetic processes. Through direct interaction, students can more easily recall key concepts, comprehend their interrelationships, and apply them in practical contexts. Despite these benefits, the use of MIMs in teaching genetics remains minimal in most Nigerian secondary schools due to inadequate teacher training, limited resources, and a lack of policy emphasis on activity-based instruction.

This study, therefore, seeks to examine the effect of manipulative instructional materials on secondary school students' lower-order thinking skills in genetics in Sokoto State, Nigeria, with attention to gender as a moderating variable.

### Objectives of the Study

The study is designed to:

1. Compare the lower-order thinking of secondary school students taught genetics using manipulative instructional materials (MIMs) and

those taught using non-manipulative instructional materials (NMIMs).

2. Compare the lower-order thinking of male and female secondary school students taught genetics using manipulative instructional materials (MIMs) in Sokoto State, Nigeria.

### Research Hypotheses

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

**H<sub>01</sub>:** There is no significant difference in the pretest lower-order thinking scores of students taught genetics using manipulative instructional materials and those taught using non-manipulative instructional materials.

**H<sub>02</sub>:** There is no significant difference in the posttest lower-order thinking scores of students taught genetics using manipulative instructional materials and those taught using non-manipulative instructional materials.

**H<sub>03</sub>:** There is no significant difference in the lower-order thinking of male and female students taught genetics using manipulative instructional materials.

### Methodology

This study adopted a pretest–posttest quasi-experimental design. The design was appropriate because it allowed comparison of two instructional strategies, involving the use of Manipulative Instructional Materials (MIMs) for one group and Non-Manipulative Instructional Materials (NMIMs) for other group. The population of the study comprised all Senior Secondary School Three (SS3) biology students in public secondary schools in Sokoto State, Nigeria. From this population, a sample size 378 ascertained using research advisor table. participants were drawn using a multistage sampling, purposive sampling and proportionate sampling technique. The multistage and purposive sampling techniques were used while selecting educational zones and schools used in this study. This resulted to the selection of four public secondary schools from two zones. From these schools, two each were assigned to experimental and control groups. Proportionate random sampling was finally used to select students from the schools and also

assigned these school to either the Experimental Group (taught using MIMs) or the Control Group (taught using NMIMs). Furthermore, 189 students were assigned each group.

A pretest using the Genetics Lower-Order Thinking Test (GLOTT) was administered to all participants prior to treatment. The pretest assessed students' ability to recall, understand, and apply basic genetic concepts in accordance with Bloom's Revised Taxonomy. The pretest scores were not used to exclude students but to establish baseline equivalence between the groups and confirm that participants exhibited comparable lower-order thinking skills before the commencement of treatment. The Experimental Group was taught genetics using manipulative instructional materials through guided hands-on activities. Students worked with DNA and chromosome models to identify gene locations and chromosome behavior. Punnett square manipulatives were used to physically represent alleles during monohybrid and dihybrid crosses, allowing students to arrange and rearrange allele combinations. Students manipulated these materials individually and in small groups under the teacher's guidance, with the teacher facilitating discussions, correcting misconceptions, and linking activities to theoretical genetic principles. The Control Group, on the other hand, was taught using non-manipulative instructional materials such as charts and diagrams of the DNA and chromosome and, also using the chalkboard to illustrate monohybrid and Punnett square crosses. Both groups were taught by the same teacher to control for teacher-related effects, and the treatment lasted six weeks, covering identical topics in genetics.

The Genetics Lower-Order Thinking Test (GLOTT), was used to assess students' ability to recall, comprehend, and apply genetic concepts. The GLOTT consisted of 40 multiple-choice items covering topics such as Mendelian inheritance, Punnett squares, and genetic terminologies. The instrument was validated by experts in biology education and measurement and evaluation to ensure content and construct validity. A test-retest reliability procedure yielded a coefficient of 0.81 using the Pearson Product Moment Correlation (PPMC), indicating high reliability and consistency. Lower-order thinking skills were operationalized based on Bloom's Revised Taxonomy, focusing on remembering, understanding, and applying. Items assessing remembering required students to recall genetic terms and definitions, understanding was assessed through explanation of concepts and interpretation of inheritance patterns, and applying involved solving monohybrid and dihybrid cross problems using learned principles. Data collected were analyzed using descriptive and inferential statistics. Means and standard deviations were used to answer the research questions, while independent samples t-tests were employed to test the null hypotheses at the 0.05 level of significance. A pretest comparison of the two groups was conducted to confirm homogeneity before treatment, ensuring that any observed posttest differences could be attributed to the instructional treatments rather than pre-existing cognitive differences.

## RESULTS

**H<sub>01</sub>:** There is no significant difference in the pretest lower-order thinking scores of students taught genetics using manipulative instructional materials and those taught using non-manipulative instructional materials.

**Table 1 Pretest Homogeneity of Lower-Order Thinking Scores**

Group	N	Mean	SD	df	t-value	p-value	Decision
Experimental	189	15.20	3.68	376	13.12	< .001	Significant
Control	189	11.39	1.54				

The results in Table 1 show the pretest performance of the Experimental and Control Groups on lower-order thinking skills in genetics. The Experimental Group recorded a mean score of 15.20 (SD = 3.68), while the Control Group had a mean score of 11.39 (SD = 1.54). The independent samples t-test yielded a t-value of 13.12 with and a p-value < .001, indicating a statistically significant difference. This suggests that the

Experimental Group had a higher baseline performance than the Control Group prior to the intervention.

**H<sub>02</sub>:** There is no significant difference in the posttest lower-order thinking scores of students taught genetics using manipulative instructional materials and those taught using non-manipulative instructional materials.

**Table 2 Posttest Comparison of Lower-Order Thinking Scores**

Group	N	Mean	SD	df	t-value	p-value	Decision
Experimental	189	32.38	3.37	376	26.25	< .001	Reject
Control	189	25.37	1.47				

The results in Table 2 present the posttest performance of students in the Experimental and Control Groups on lower-order thinking skills in genetics. Students in the Experimental Group recorded a mean score of 32.38 (SD = 3.37), while those in the Control Group had a mean score of 25.37 (SD = 1.47). The independent samples t-test yielded a t-value of 26.25 with and a p-value < .001. This indicates a highly statistically

significant difference in favor of the Experimental Group, showing that manipulative instructional materials substantially improved students' lower-order thinking skills compared to conventional instruction.

**H<sub>03</sub>:** There is no significant difference in the lower-order thinking of male and female students taught genetics using manipulative instructional materials.

**Table 3 Gender Comparison in Experimental Group**

Group	N	Mean	SD	df	t-value	p-value	Decision
Male	89	32.02	3.63	173	-1.37	.172	Fail to
Female	100	32.70	3.10				

The results in Table 3 present the performance of male and female students in the Experimental Group on lower-order thinking skills in genetics. Male students recorded a mean score of 32.02 (SD = 3.63), while female students had a mean score of 32.70 (SD = 3.10). The mean difference of 0.68 shows a marginal advantage in favor of the female students. The independent samples t-test yielded a t-value of -1.37 with and a p-value of 0.172, which is not statistically

significant at the 0.05 level. This result indicates that the use of manipulative instructional materials had a similar effect on the lower-order thinking skills of both male and female students. Accordingly, the null hypothesis for gender differences was not rejected.

### Discussion of Findings

The discussion of findings is presented in line with the results obtained from the study. The discussion highlights the

effects of manipulative instructional materials (MIMs) on secondary school students' lower-order thinking skills in genetics and examines the role of gender in students' performance.

The findings of the study revealed a statistically significant difference in the lower-order thinking scores of students taught genetics using manipulative instructional materials and those taught using non-manipulative instructional materials. Students who were exposed to manipulative instructional materials recorded higher mean scores than their counterparts taught with conventional instructional materials. This indicates that manipulative instructional materials significantly enhanced students' ability to recall, understand, and apply genetic concepts more effectively than traditional instructional approaches.

The improvement observed in students' lower-order thinking skills can be attributed to the interactive and experiential nature of manipulative instructional materials, which allow learners to engage directly with abstract genetic concepts. The use of DNA models, chromosome kits, Punnett square manipulatives, and dihybrid cross boards promoted active participation and enabled students to visualize and manipulate genetic processes that are often difficult to comprehend through verbal explanations alone. This finding is consistent with constructivist learning theory, which emphasizes that learners develop deeper understanding when they actively construct knowledge through hands-on experiences (Schunk, 2020; Mupa & Chinooneka, 2023).

In addition, the finding can be explained within the framework of Bloom's Revised Taxonomy, which identifies remembering, understanding, and applying as foundational cognitive processes necessary for meaningful learning (Anderson & Krathwohl, 2001). Manipulative instructional materials supported students in recalling genetic terminologies, explaining inheritance patterns, and applying genetic principles to problem-solving situations. Recent studies have shown that instructional strategies that target these lower-order cognitive processes significantly enhance conceptual clarity and retention in science

subjects (Akpan & Beard, 2021; Yusuf & Afolabi, 2022).

The findings of this study are consistent with recent empirical research. Bello, Sadiq, and Musa (2021) reported that students taught biology concepts using manipulative instructional materials demonstrated significantly higher achievement and conceptual understanding than those taught using conventional methods. Similarly, Moyer-Packenham et al. (2022) found that manipulative-based instruction improves cognitive engagement by transforming abstract scientific concepts into tangible learning experiences. These findings collectively reinforce the effectiveness of manipulative instructional materials in improving students' lower-order thinking skills in genetics.

Conversely, students taught using non-manipulative instructional materials such as textbooks, chalkboards, and teacher-centered explanations recorded relatively lower performance. This may be due to the passive nature of such instructional methods, which often emphasize rote memorization and limit students' active involvement in the learning process. Recent studies have noted that traditional instructional approaches are less effective in promoting meaningful understanding and application of scientific concepts, particularly in abstract areas such as genetics (OECD, 2019; Gambari & Yusuf, 2021).

The findings further revealed that male and female students taught genetics using manipulative instructional materials performed similarly in terms of lower-order thinking skills. Although female students recorded a slightly higher mean score than male students, the difference was not statistically significant. This suggests that manipulative instructional materials provide equal learning opportunities for both genders and support inclusive classroom participation. This outcome implies that the effectiveness of manipulative instructional materials is not influenced by gender. The hands-on and learner-centered nature of these materials allows all students to engage meaningfully with instructional tasks regardless of gender. This finding aligns with recent studies which reported that gender differences in science

achievement tend to diminish when activity-based and student-centered instructional strategies are employed (Brotman & Moore, 2020; Yusuf, Gambari, & Olumorin, 2021). Consequently, manipulative instructional materials can be regarded as effective tools for promoting gender equity in biology classrooms.

### Summary of the Discussion

The discussion of findings revealed that manipulative instructional materials significantly enhanced secondary school students' lower-order thinking skills in genetics. Students exposed to manipulative instructional materials demonstrated superior ability to recall, understand, and apply genetic concepts compared to those taught using non-manipulative instructional materials. This improvement was attributed to the interactive and experiential nature of manipulative instructional materials, which transformed abstract genetic concepts into concrete and meaningful learning experiences. The findings were explained using constructivist learning theory and Bloom's Revised Taxonomy, both of which emphasize active engagement and progressive cognitive development as essential components of effective learning.

The discussion also revealed that the use of manipulative instructional materials had a similar effect on the lower-order thinking skills of male and female students. Although slight differences in mean scores were observed, these differences were not statistically significant, indicating that manipulative instructional materials provide equitable learning opportunities across gender. Overall, the discussion established that manipulative instructional materials are effective, inclusive, and suitable for improving foundational cognitive skills in genetics at the secondary school level.

### Conclusions

Based on the findings of this study, it is concluded that manipulative instructional materials are effective tools for improving secondary school students' lower-order thinking skills in genetics. The use of hands-on instructional materials such as DNA models, chromosome kits, and Punnett square manipulatives significantly improved students' ability to recall,

comprehend, and apply genetic concepts when compared to conventional instructional methods. The study also concludes that manipulative instructional materials are gender-neutral, as both male and female students benefited equally from their use. Consequently, manipulative instructional materials can be regarded as valuable resources for enhancing conceptual understanding and promoting inclusive science education in secondary schools.

### Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

1. Biology teachers should adopt the use of manipulative instructional materials in the teaching of genetics to enhance students' lower-order thinking skills and promote meaningful learning.
2. School administrators and educational policymakers should ensure the provision and adequate supply of manipulative instructional materials in secondary schools to support effective biology instruction.
3. Teacher training institutions and professional development programs should emphasize the design, selection, and effective use of manipulative instructional materials to equip teachers with practical instructional skills.
4. Curriculum planners should integrate manipulative-based instructional strategies into the biology curriculum, particularly for abstract topics such as genetics.
5. Future researchers should replicate this study using different science subjects, educational levels, or research designs to further validate the effectiveness of manipulative instructional materials on students' cognitive development.

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## STUDENTS' ATTITUDE TO BIOLOGY IN INFORMATION COMMUNICATION AND TECHNOLOGY IN EKITI STATE SECONDARY SCHOOLS

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### Abstract

This study investigated Students' Attitude to Biology in Information Communication and Technology in Ekiti State Secondary Schools. One research question was raised and one hypothesis was generated. The study adopted a descriptive research design in Ekiti State and the sample consisted 137 Students that was selected using multistage sampling. (BAS) was used to test the attitude of students. The validity of the instrument was established through face and content validity. Cronbach's alpha method was used to establish the reliability of the Instrument. The data obtained were analyzed using descriptive and inferential statistics tested at 0.05 level of significant. The results revealed that there was no significant gender difference in the attitude of students taught with ICT and those that were not taught. The result also revealed that the students cultivated positive attitudes to learning of Biology. This implies that the attitude of students to Biology is independent of their gender. Its recommended that the teachers should endeavor to take the Biology students to ICT rooms in Schools to teach the students.

**Keywords:** Attitude, Gender, ICT, Biology, Student, Teachers

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### Introduction:

Biology is a branch of science that deals with the study all living organism such as, plant and animal. Biology is the science of life. Its name is derived from Greek words "bio" (life) and "logos" (study). (Bagley 2017). Biology is the study of all life. (Oxford Dictionary 2014). According to Ugwu and Eze (2015), Biology education enables individuals to understand themselves, the different parts of their bodies, and their functions. It instills scientific skills and attitudes in individuals, shaping their approach to personal and social problems.

Biology as a school subject may be a factor in improving the lives of students and their immediate environment. Biology, a fundamental branch of science, delves into the study of life and living organisms, elucidating their intricate structures, functions, behaviours, and interrelationships. It plays a pivotal role in our understanding of the natural world and is indispensable to various scientific disciplines. Biology, often referred to as life science, encompasses the scientific exploration of living organisms and their interactions with the environment. It scrutinizes organisms at different levels, from molecular interactions within cells to the

complex ecosystems that sustain life. As described by Campbell et al. (2020). Biology elucidates the processes of life, emphasizing evolution, energy transfer, and the continuity of life forms (Campbell et al., 2020). Biology is very wide and voluminous in that it often overlaps with other science subjects (Adekunle 2018). Since nature of biology calls for a unique way of teaching it, thus, the teacher is saddled with tasks which include among others, choice and provision of materials and experience to meet learners' expectation and aid learning cited by Ezechi (2018).

This present age has witnessed technological development unprecedented in human history. The launching into space of satellites, the industrial revolutions, the inventions of cars, aircrafts, sophisticated machines and weapons, above all the amazing breakthrough in Information and Communication Technology, has changed every sectors and organisation around. Information and technology makes work and every human activity more effective and easy. Biology is a branch of science that deals with the study all living organism such as, plant and animal. Biology is the science of life. Its name is derived from Greek words "bio (life) and "logos" {study}. (Bagley 2017). Biology is the study of all life, as defines by the Oxford Dictionary. Biology is a widely studied subject. The knowledge of it, calls for a balanced secondary school education. Biology as a school subject may be a factor in improving the lives of students and their immediate environment. In a developing country like Nigeria, the use of ICT in the teaching of Biology should be promoted in all secondary schools, since the national policy on education states that "the broad aims of secondary education within overall National objectives should be preparation of students for higher education". In specific terms, secondary education should equip students so that they will be able to live effectively in our modern age of science and technology.

Biology is one of the important science subjects that focuses on plants and animals. It is one of the pre-requisite subjects in the field of learning that

contributes immensely to the technological growth of the nation (Ahmed, 2018). Biology is an inquiry-oriented subject to which practical activities is very essential. It is a subject that involves students in the acquisition of series of process skills such as observing carefully, classifying, interpreting, predicting, event, designing experiments, organizing information, reporting completely and accurately, generalizing among others.

The study of biology is essential for the nation's scientific and technological development, without sound knowledge and wholesome attitude towards Biology; the much needed and vouched technological breakthrough may not be achieved. For example, the knowledge of biology is brought to play in the area of manufacturing and processing industries, medicines, food production and pharmaceuticals among others.

The National Policy of Education (2014) says that 'the broad aim of Secondary Education within overall national objectives should be preparation on higher Education. In specific terms, Secondary Education should equip Students so that they will be able to live effectively in our modern age of Science and Technology. Information and Communication Technology (ICT) has positively transformed effectively every aspect of human lives, such as, aviation, agriculture, manufacture industries, banks, hospital, telecommunication companies etc. The penetrating influence of ICT is not only limited to these sphere of human endeavour but also to the field of education where it is perceived as transforming agent in Education delivery and education methodology.

ICT also refers to technologies that provide access to information through telecommunication. This includes the Internet, wireless network, cell phones, and other communication mediums (Techtarget, 2025). ICT is the infrastructure and components that enables modern computing among the IC technologies, tools and systems is to improve the way humans create, process and share data or information with each other (Kiravn.

Awati and Pratt 2025). ICT is a revolution that involves the use of computers, internet and other telecommunication technology in every aspect of human endeavour (Adebayo, Ayoku and Adeseko 2020). According to Baro (2011), he defines ICT as electronic or computerized devices assisted by human and interactive materials that can be used for a wide range of teaching and learning for public or personal uses. ICT, according to Ibe Bassey (2011) is regarded as a critical tool for preparing and educating students with the required skills for the global work place. Jimoh in Owolabi (2018) refers to ICT as the handling and processing of information (text, image, graphics and instructions) for use by means of electronic and communication devices such as computers, cameras and telephone. When ICT materials combine with internet, it creates a channel for students to obtain a huge amount of human experiences and guide students to enter the global community. In this way, the students will not only express their personal views, thoughts, and experiences, but also can learn to live in the real world.

Tella (2010) says that The use of ICT in teaching and learning is a relevant and functional way of providing education to learning in order to assist them in imbibing the required capacity for the world of work. Ajayi, Osagie and Ozima (2019) posited that with the aid of ICT, teachers can take students beyond traditional limits, ensured their adequate participation in teaching and learning process and create vital environments to experiment and explore. However, the application of ICT needs expensive hardware and software which becomes the big obligations for schools and parents. It is also necessary that both Teachers and Learners should have basic technology knowledge before they apply ICT. Chepkonga (2018) adds that a broad definition of ICT includes computers, the internet, telephone, television, radio and audio-visual equipment. Chepkonga further explains that ICT is any device and application used to access, manage, integrate, evaluate, create and communicate information and knowledge. Digital

technology is included in this definition as services and applications used for communication and information processing functions associated with these devices.

ICT enables researchers, students and teachers to have access to the best resources available in any discipline regardless of the location. This is to prove that the role of Teachers in teaching and learning process is changing and that in the future, schools will depend on their capability to join the new information society. The most worrisome of the utilization of these facilities by the students is their poor attitude towards the facilities: most of the students have abused the importance of ICT facilities to the detriment of their studies. Students have abandoned their studies for regular chatting on the internet, connecting with friends and irrelevant communication all over the world while utilizing the ICT facilities, academic libraries, even personal phones were not left out in this distracting act of the students to the extent that most of them lose their sleep and subsequently making them to absent themselves from the classroom.

In Education setting, ICT is a very useful tool which Student uses for improvement in their way of study. In this study the researcher will consider several important issues with respect to the use of ICT in educational setting including the effectiveness of ICT in the education, what measures are being taken to create ICT enhanced learning environments and the use of ICT in formal education.

Students' attitude towards a specific discipline will affect their learning. Shonfeld and Magen-nagar (2018) opined that Students attitude towards education significantly alter achievement in education, therefore identification and influence of attitude became to be an essential part of educational research. Attitudes are one of the most studied aspects of social functioning. An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations to which it's related. Students learning experience affects their attitude

positively; increase their motivation for learning, as result which leads to higher achievement in learning. Several types of scales have been developed to measure attitudes. One of the most recognized scales for measuring attitudes is the Likert – type scale. The scale demands that individuals make decision on their level of agreement. It is hoped that the inclusion of ICT in the School curriculum, the training of man power, and hopefully the improvement in erratic power supply will go a long way in helping the School system achieve good attitude of students to learning science subject.

Students attitude to the use of ICT in the classroom have attracted the attention of many researchers. Attitudes to computers can be seen as significant determinants of behaviour that may influence computer utilization hence, attitudes are considered to be a good sign to determine whether students appreciate the utilization of computers in their learning.

The attitude of the teacher to using technologies in the classrooms is a major factor in how successful technology integration will be (Meyer 2012). The teachers who use technology extensively in their lessons tends to have a high level of confidence in pedagogical technology skills and focus on a learning centred approach according to Voogt (2010). They are more engaged in professional development activities and collaboration with colleagues that teachers who don't use technology very often. A number of factors must be accounted for during analysis of teachers' negative attitude to technology integration.

Teachers' fear of being replaced by technology also create negative attitudes (Saba, Ngepah and Odhiambo 2024). While most teachers believe technology integration in the classroom will enhance their instruction, many consider the training they receive technology in order to utilize new technology insufficient, and available technology in schools is limited (kazu 2011). The technology training is often offered at inconvenient times or at other locations on different computers than those used in the classroom. Although training experiences in themselves do not directly affect anxiety and attitude to

technology. They have indirect effects on anxiety and attitude through the medication of other factors such as a daily use of computers as a result of having training (Saba et al 2024)

Gender could be factors that influence the level of utilization of ICT in teaching and learning of biology. Gender issue is an important one in Science Education, many differences have been documented by researchers between male and female, Opera (2011) opined that boys performed better than girls. Roberts, (2016) asserted that boys and girls have differentiated abilities, boys being superior in numerical aptitudes and science reasoning while girls are superior in verbal fluency. Bello, Abimbola and Hamzat (2017) showed that there are no significant differences in achievement and interest of male and female Students in Biology, that both male and female achieve equally in Biology when exposed to the same treatment and given equal opportunity.

#### **Statement of the Problem**

Education worldwide is facing a significant challenge in preparing Students for “our future ‘knowledge – based’ society”. There are times when most students are not prepared to use ICT facilities in some schools that have them, because their teachers could not use it appropriately or applied them into teaching and majorly it is not existing in some Schools, they are not equipped to integrate the new information communication and technologies. The state of teaching and learning process in Nigeria secondary schools calls for reviews, as most of the teachers in the public secondary schools still believe in the conventional method of teaching in the classroom. The conventional method of teaching seems to have limited the extent to which teachers can move with trend of changes in the global world. However, the conventional method has been used for educational progress over the years. Nevertheless, it seems the method is fast becoming old as it makes the teachers the only source of knowledge with little or no contribution from the students.

Students' challenges and their attitude towards learning of biology lies on their inability to understand most of

the concept of the subject taught. Students attitude could either be a negative or positive attitude, depending on the method of the teacher and this determines their levels of interest in learning., hence the need for this study.

### Purpose of the study:

The purpose of the study was to examine whether there will be any difference in the attitude of students taught with ICT and those taught without ICT in Biology.

### Research question:

What attitude do students cultivate to learning of Biology in Secondary Schools?

### Hypotheses:

There is no significant gender difference in the attitude of students taught with ICT and those that were not taught with ICT facilities

### Methodology

The research adopted a descriptive design. The population of the study consisted of 19,603 SS11 Students offering Biology in Ekiti State Secondary School as at the time for this study. A sample of 137 was used for the study. Samples were selected from six Schools using purposive sampling techniques

**Table 1:** Mean Response of Attitude Students Cultivate Towards Learning of Biology in Secondary Schools (N=137)

Variables	Mean	S.D	Remarks
Students Attitude towards Biology	3.00	0.868	Positive

Table 1 shows that average response of the respondents on attitude cultivated by students towards learning of Biology had mean value of 3.00 above and standard deviation of 0.86. Since cut-off mean for positive attitude toward Biology was 2.50, it implies that students cultivate positive attitude towards Biology. However, there may be need to further subject the data to t-test statistical analysis to know whether there is a

which were selected from three Local Government area from one Senatorial district within the state. The instrument used for the study was Biology Attitudinal Scale, BAS was designed by the researcher to elicits some information's from the respondents. Two methods were used to validate the instruments, face and content validity. Cronbach's Alpha method was used to establish the reliability of the instrument BAS. The research question was answered using Mean and standard deviation while the Hypothesis was tested using ANCOVA. The hypothesis was tested at 0.05 level of significance.

### Result:

This section contains the descriptive analysis of the data collected to answer the research question, as well as hypotheses testing.

### Descriptive Analysis

**Research Question:** What Attitude do Students' Cultivate towards Learning of Biology in Secondary Schools?

In order to answer the question, responses on items 1-20 of Biology Attitudinal Scale were obtained item by item and subjected statistical analysis involving mean and standard deviation. To determine positive or negative attitude, cut-off mean of 2.50 was used ( $\frac{4+3+2+1}{4} = 2.50$ ).

Table 1: Mean Response of Attitude Students Cultivate Towards Learning of Biology in Secondary Schools (N=137)

difference in the attitude cultivated by those taught Biology with aid of computer and those taught without

### Hypothesis Testing.

**Hypothesis:** There is no significant gender difference in the attitude of students taught with ICT and those that were not taught with ICT facilities.

**Table 2:** Analysis of Covariance showing gender difference in the attitude of students taught with ICT and those that were not taught with ICT facilities

Source	SS	Df	MS	F	Sig.
Corrected Model	251.917 <sup>a</sup>	3	83.972	2.364	.074
Group	152.442	1	152.442	4.291	.040
Gender	70.506	1	70.506	1.985	.161
Group * Gender	.692	1	.692	.019	.889
Error	4725.222	133	35.528		
Total	500941.000	137			
Corrected Total	4977.139	136			

Table 2 indicated that  $F(1,133) = 0.019$ ,  $p=0.889$ . Since the p-value is greater than 0.05 level of significance, the null hypothesis is not rejected. Therefore, there is no significant gender difference in the attitude of students taught with ICT and those that were not taught with ICT facilities. This implies that the effect of treatment on the attitude of students toward Biology is independent of their gender. Similarly, the main effect of gender was not significant,  $F(1,133)=1.985$ ,  $p=0.161$ . However, the main effect of the treatment was statistically significant,  $F(1,133) = 4.291$ ,  $p=0.40$ .

#### Discussion

The findings from the study was that the average response of the respondents on attitude cultivated by students towards learning of Biology had mean value above the cut-off mean of 2.50 which implies that students cultivate positive attitude towards Biology. Thus, positive attitude of students towards learning of Biology underscore the role of effective classroom teaching.

The results indicated that there was no significant gender difference in the attitude of students taught with ICT and those that were not taught with ICT facilities.

This implies that the student's attitude to Biology is independent of their gender. Meanwhile, Ford, Miller and Moss (2017) discovered that females experience more difficulty while finding information on internet and those females feel competent and comfortable while using the internet, and that they use the internet less than their male counterparts.

Volman, Zijlstra, Liisette and Bonne (2017) further found differences on experience and attitude towards ICT with girls. Girls seem to be less positive on ICT attitude than boys. Males are suggested to have better ICT and computer skills compared to the females. However, with the findings from this study the researcher is of the opinion that gender attitude and students' performance in Biology remain inconclusive, there will be need for further research to establish whether the difference exist.

#### Conclusion:

Based on the findings of the study, it can be concluded that students' cultivate positive attitude to learning of Biology in some part of Ekiti state secondary Schools . The attitude of students to biology is independent of their gender.

#### Recommendation:

Based on the findings from the study its recommended that government should provide the public schools with ICT facilities along

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## EFFECT OF COMPUTER-AIDED INSTRUCTION STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' PERFORMANCE IN BIOLOGY

BY

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### Abstract

*This study examined the effects of Computer-Aided Instruction (CAI) on students' performance in Biology. The population comprised all Senior Secondary School Two (SS II) Biology students across public secondary schools, with a sample of 109 students from two schools selected using a multistage sampling procedure. One group received instruction through CAI (experimental), while the other (control group) was taught using conventional methods. The Biology Performance Test (BPT) was used and this instrument was validated by experts and tested with reliability coefficient of 0.82. Data were analyzed using means, standard deviations, and independent samples *t*-tests. Results showed that both groups improved after instruction, but the CAI group performed significantly better than the control group. Pre-test scores showed no significant difference, confirming the two groups homogeneity. The findings indicate that CAI enhances understanding, retention, and engagement, making it more effective than conventional methods in improving Biology performance. The study concludes that integrating CAI into Biology instruction significantly improve students' academic achievement and interest. It is recommended that schools adopt CAI, provide teachers with training, and ensure adequate computer facilities and instructional software to maximize learning outcomes.*

**Keywords:** Academic Performance, Computer-Aided Instruction, Nigeria, Student Engagement, Teaching Strategies.

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### Introduction

Education remains one of the most potent instruments for personal development, self-reliance, and national growth. In contemporary societies, the demand for education that equips individuals with relevant scientific, technological, and problem-solving skills has become increasingly important. Education is not merely the acquisition of knowledge but a process through which learners develop abilities that can be applied to solve real-life problems and contribute meaningfully to societal development. Ayeni (2022) emphasized

that education serves as the bedrock of human progress, enhancing national productivity, reducing poverty, and preparing individuals for leadership roles in various sectors of society.

Science education plays a critical role in achieving these educational goals, as science drives technological advancement, improves health outcomes, and promotes sustainable development. Usman et al. (2022) noted that science contributes significantly to national wealth creation, environmental sustainability, and improved

quality of life. Through science education, learners develop critical thinking skills, inquiry abilities, and evidence-based reasoning necessary for addressing societal challenges

Biology is the scientific study of life and living organisms, encompassing the structure, function, growth, origin, evolution, and interactions of organisms with their environment. It is one of the three major science subjects in the Nigerian senior secondary school

curriculum and has the highest enrollment among science subjects (Akinsolu & Fadokun, 2016). Biology is fundamental to careers such as medicine, pharmacy, nursing, agriculture, biotechnology, and environmental sciences. As such, effective teaching and learning of Biology are essential for human development and national progress. Despite the importance of Biology, students' academic performance in the subject has remained a major concern.

**Table 1: Students' Performance in Biology in WASSCE (2019–2024) in Ekiti State, Nigeria**

Year	Total Candidates	A1–B3	%	C4–C6	%	D7–D8	%	F9	%	% Pass	% Fail
2019	6,691	744	11	3,200	48	1,657	25	1,060	16	59	41
2020	6,022	1,622	27	3,108	52	668	11	624	10	79	21
2021	5,641	1,120	20	3,333	59	761	13	427	8	79	21
2022	2,499	491	20	1,509	60	185	7	314	13	80	20
2023	5,563	824	15	3,098	56	1,069	19	572	10	71	29

**Source:** Ministry of Education, Planning, Research and Statistics Department, Ekiti State (2024)

Evidence from the West African Senior School Certificate Examination (WASSCE) results in Ekiti State between 2019 and 2023 shows a fluctuating and generally unsatisfactory performance trend, particularly at the credit level required for admission into science-related university courses. Although some improvement was recorded in certain years, the percentage of students attaining high grades (A1–B3) remains low, while failure rates persist. This situation limits Students' opportunities to pursue competitive science-based careers and raises concerns about the effectiveness of current instructional practices.

The Chief Examiner from the above Reports have attributed students' poor performance in Biology to the following

factors such as ineffective teaching methods, overreliance on lecture-based approaches, inadequate instructional materials, and low student motivation and interest. Conventional teaching methods are often teacher-centered, making students passive recipients of information and limiting opportunities for active participation, inquiry, and meaningful learning (Faletiba, 2019). Such methods may not adequately support students' understanding of abstract biological concepts, leading to poor retention and performance.

Given the increasing influence of technology in education, there is a growing need to adopt instructional strategies that promote active, learner-centered, and inquiry-based learning, CAI



involves the use of computers and instructional software to present learning materials through tutorials, simulations, animations, and interactive activities. According to Fashiku (2022), CAI enhances learning by providing immediate feedback, supporting self-paced learning, and catering to diverse learning styles. In Biology, CAI has the potential to simplify complex concepts, improve visualization of abstract processes, and increase Students' engagement and understanding.

Research has shown that CAI can enhance Students' interest, retention, and academic performance when compared to conventional teaching methods (Ok et al., 2020). By promoting active participation and individualized learning experiences, CAI aligns with the demands of 21st-century education and offers a promising approach to improving students' learning outcomes in Biology.

In view of the persistent fluctuation in students' performance in Biology and the limitations of conventional teaching methods, it becomes necessary to empirically examine the effectiveness of computer-aided instruction. Therefore, this study investigates the effects of Computer-Aided Instruction on senior secondary school students' academic performance in Biology in Ekiti State, Nigeria, by comparing students taught using CAI with those taught using the conventional teaching method

### **Statement of the Problem**

It was noted that students' academic performance in Biology at the senior secondary school level has remained inconsistent and generally unsatisfactory over the years. Despite Biology being one of the most widely offered science subjects and a prerequisite for many science and health related careers, many students experience difficulties in understanding key biological concepts, which is reflected in their poor

performance in both internal and external examinations.

It was further noted that many students depend largely on rote memorization rather than meaningful understanding of biological processes. This situation is often accompanied by low interest, limited classroom participation, and negative attitudes toward the subject. Biology is frequently perceived as difficult and abstract, particularly when taught using conventional, teacher-centered instructional methods such as the lecture method, which remains predominant in many secondary schools.

In addition, it was observed that conventional teaching methods provide limited opportunities for active learning, inquiry, and visualization of complex biological concepts. Consequently, students tend to become passive learners who struggle to relate classroom instruction to real-life applications. This instructional practice may partly account for the fluctuating performance recorded in Biology in the West African Senior School Certificate Examination (WASSCE) in Ekiti-State between 2019 and 2024

Although computer-aided instruction (CAI) is recognized as a learner-centered and interactive instructional strategy capable of enhancing students' engagement and understanding through visual and self-paced learning experiences, its application in the teaching of Biology remains limited. It was noted that many Biology teachers continue to rely heavily on conventional teaching methods, with little empirical evidence available on the effectiveness of CAI in improving students' academic performance.

Therefore, the problem addressed in this study is the persistent fluctuation and generally low academic performance of senior secondary school students in Biology, which may be linked to the

continued use of conventional teaching methods. This study seeks to examine whether computer-aided instruction can significantly improve students' academic performance in Biology compared with the conventional teaching method in Ekiti State, Nigeria.

### Objectives of the Study

The general objective of this study is to examine the effect of computer-aided instruction on students' academic performance in Biology.

The specific objective is to:

1. determine the performance of students taught Biology **before and after** exposure to computer-aided instruction and the conventional teaching method.

### Research Questions

The following research questions was formulated to guide this study:

1. What is the performance of students taught Biology before and after exposure to computer aided instruction and conventional teaching method?

### Research Hypotheses

The following research hypotheses are formulated to guide this study:

1. There is no significant difference in the performance of students in experimental and control group before treatment.
2. There is no significance difference in the performance of students in experimental and control group after treatment.

### Literature Review

#### Students' Performance in Biology

Academic performance refers to a successful accomplishment or Performance in particular subject area. It is indicated by grades, marks and scores of descriptive commentaries. Academic performance also refers to how Student's deal with their studies and how they

cope with or accomplish different tasks given to them by their teachers in a fixed time or academic year. Fajola (2018), used the notion of academic self-concept in referring to Individuals' knowledge and perceptions about themselves in academic performance, and convictions that they can successfully perform a given academic tasks at designated levels. Fajola (2018) further stated that academic self-concept represents a more past-oriented, aggregated and relatively stable judgment about one's self-perceived ability in a particular academic domain while academic self-efficacy represents a context specific and relatively future.

Performance in Biology has consistently been a challenge in secondary schools worldwide. Numerous studies have been conducted to identify the underlying causes of this persistent issue, particularly within science subjects like Biology , These studies have explored various factors influencing student performance, with a focus on general academic achievement. Gu et al. (2024) highlights that socioeconomic status and the overall family environment significantly influence students' academic achievement, with parental involvement playing a key mediating role between these family factors and learners' performance outcomes. . Additionally, factors such as the educational and occupational status of the home, as well as the teacher's engagement in teaching, have been shown to influence student outcomes. Other contributing factors include students' attitudes toward science and teachers' workloads. Interestingly, studies have found that the location of the home (urban vs. rural) does not significantly affect students' achievement. According to Kissan (2016), home background factors are often more influential than those within the school environment in shaping students' performance.



A Study was conducted by Adewale, (2016) investigating the Academic Performance in Biology at Secondary School Certificate Examination (SSCE) and the Influencing Factors among Students in Owerri Municipal of Imo State, Nigeria. This study is undertaken to ascertain the grading of the academic performances of the Students were classified into four categories. For students in these institutions. The SSCE results in Biology for five consecutive years from 2009-possible factors that account for diverse academic performances in Biology subject among the sampling information from the teachers and students on the factors that affect academic revealed that academic performances in Biology in the schools under investigation were widely 2013 were collected from each of five schools with the cooperation of the school Principals. The performances in the schools. It is recommended that schools under same administrative management structure should properly integrate students welfare especially health into school conducted for secondary school students in the English speaking countries of West Africa. Different in term of general scores per schools and candidates. Teachers' factors, school's factor, performance, different structured questionnaires were prepared for the two groups. Findings management should be uniformly staffed and equipped by the government. Moreover, school management structure should properly integrate students welfare especially health into school planning.

### **Concept of Computer-Aided Instruction in Education**

Computer Aided Instruction (CAI) is an automated instructional strategy in which a computer is used to present an instructional program to the learners through an interactive process on the computer under the supervision of a teacher. Computer Aided Instruction (CAI)

refers to using computers to present instructional materials interactively, creating a controlled, personalized learning experience for each student. Some tutorials adapt to students' progress by adjusting the pace and providing feedback, enhancing individualized instruction (Habib et al, 2019). The benefits of CAI in modern education are significant and should not be overlooked. CAI is an aspect of e-learning facilities teachers use to facilitate and enhance effective teaching in the classroom the learner and the computer. The learner responds to the computer's illustration (Gambariet et al., 2016). According to Dap-og and Orongan (2021), CAI is using the computer on a time shared basis to perform any instructional functions. The functions include presenting materials or problem situations, guiding learners' thinking, responding to learners' questions, assessing learners' performances, selecting materials to be delivered, assigning tasks to be performed, or a combination of all these functions. The computer-assisted instructional strategy could be individualize and cooperative among the learners. This depends on objectives, content, teaching, and learning experiences (Zubairu, 2019).

### **Computer Aided Instruction and Students' Performance in Biology**

The integration of computer technology into traditional instruction is not entirely a recent development. Achor and Ukwuru (2014) stated that education evolved from learning about computers to learning with computers and to finally learning through computers. Computer-based teaching and learning has been found to always produce positive effects in the classroom, if properly adopted.

In 2022, Tantry and Sofi presented a research in determining the effectiveness of computer-aided instruction on basis of intelligence, quasi -experimental pre -test,post -test two groups design were

used . The two groups both groups before being subjected to experimentation. The experimental group was taught the first chapter of 10th grade biology, that is, LIFE PROCESSES, through computer-aided higher in biological science among secondary school children taught through computer-aided post tests were administered to both groups. The academic achievement of the students were randomly divided into experimental and control groups. A pre-test was administered to instruction, and the control group, through the traditional method of teaching for one month in the Kashmir division. The sample of the research consisted of 100 10th-class pupils from two groups were compared. Results indicated that academic achievement and retention are two groups were compared using the test similarly, the means of the scores of retention of the developed for measuring retention. The means scores of academic achievements of the government schools selected randomly. To equalize the students into two groups on the measured using the criterion reference test developed by the author; a similar test was academic achievement and retention in the biological sciences among secondary school children instruction than those taught through traditional methods of teaching.

Chieke, & Anaeke, (2019). Also conducted a research on the Effects of computer assisted instruction on students' achievement in Biology. quasi - experimental pre-test, post-test non-equivalent control group research design was adopted for the study. Data collected after the treatments were analyzed using means, standard deviation, and Analysis of Covariance (ANCOVA). The results of the study among others indicated that CAIP had a significant effect ( $F = 6.90$ ,  $p = 0.02 < 0.05$ ) on students' achievement in biology. Chieke Anthonia Ifeyinwa (2024) investigated the effect of

Computer Assisted Instruction Package (CAIP) on secondary school students' achievement in biology. A quasi-experimental pre-test, post-test non-equivalent control group research design was adopted for the study. The study was conducted in Awka Education Zone of Anambra State in the 2017/2018 academic session. The sample consisted of 320 senior secondary year two (SSII) male and female biology students. The instruments: Biology Achievement Test (BAT) was used for data collection. Reliability index of 0.81 was obtained using Kuder-Richardson reliability technique. Data collected after the treatments were analyzed using means, standard deviation , and Analysis of Covariance (ANCOVA). The result of the study among others indicated that CAIP had a significant effect ( $F = 6.90$ ,  $p = 0.02 < 0.05$ ) on students' achievement in biology.

### **Research Gaps**

Despite numerous studies on students' performance in Biology, most research has focused on general factors such as home background, parental involvement, teacher effectiveness, and students' attitudes. While these studies provide insights into environmental and socio-demographic influences, few have examined the impact of instructional strategies, particularly technology-based methods, on learning outcomes. Previous research on computer-aided instruction has shown positive effects on students' achievement and retention in Biology; however, these studies were conducted outside Ekiti -State, often on specific topics or student groups, and provided limited comparison with conventional teaching methods. Additionally, there is insufficient empirical evidence using pre-test and post-test experimental designs within regular classroom settings to determine the effectiveness of computer-aided instruction on students' overall performance. This gap highlights the

need to investigate the effect of computer-aided instruction on senior secondary school students' performance in Biology in Ekiti -State, particularly by comparing learning outcomes before and after exposure to computer-aided and conventional teaching methods.

### Methodology

This study adopted a quasi-experimental pre-test and post-test two-group design to examine the effect of Computer-Aided Instruction (CAI) on students' performance in Biology. One experimental group received instruction through CAI, while the control group was taught using the conventional method. The population consisted of all 8,961 Senior Secondary School Two (SSS II) Biology students across the 205 public secondary schools in Ekiti -State. A sample of 109 students was drawn from two schools using a multistage sampling technique, which involved randomly selecting a senatorial district and two Local Government Areas (LGAs), purposively selecting schools with functional computer facilities, and randomly assigning schools to experimental and control groups. The Biology Performance Test (BPT),

developed by the researcher and based on WASSCE questions covering Plant and Animal Cells and Photosynthesis, served as both pre-test and post-test. The instrument's validity was established through expert review by lecturers, test specialists, and experienced Biology teachers, while reliability was confirmed via the test-retest method, yielding a coefficient of 0.82. The experiment was conducted over eight weeks, including one week of pre-treatment preparation, six weeks of treatment, and one week of post-testing. During treatment, students in the experimental group used the CAI package at their own pace, while the control group received conventional instruction. Data collected from pre- and post-tests were analyzed using means and standard deviations to answer research question, and independent samples t-tests were used to test hypotheses at the 0.05 level of significance.

### Results

**Research Question 1:** What is the performance of students taught Biology before and after exposure to computer aided instruction and conventional teaching method?

**Table 1: Descriptive Analysis of Students' Performance Before and After Treatment**

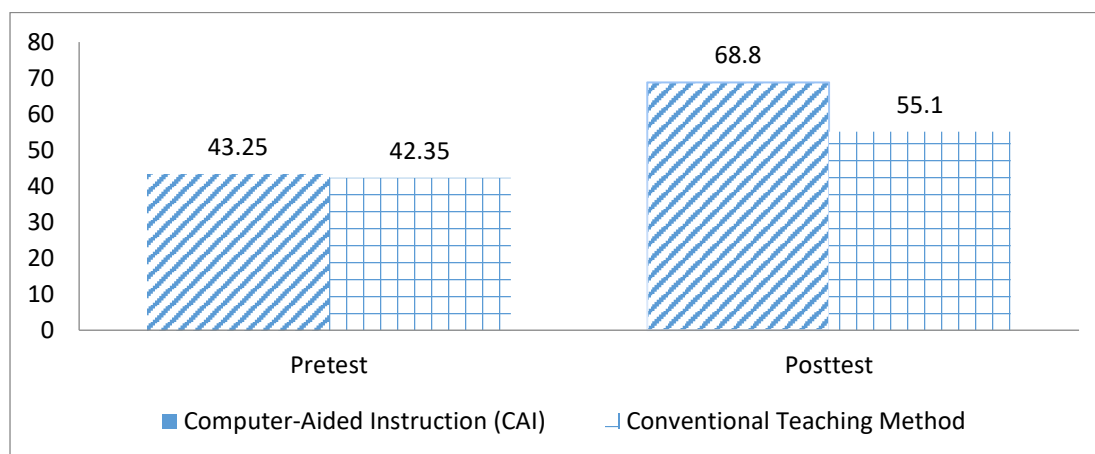
Group	N	Before		After		Mean Difference
		Mean	SD	Mean	SD	
Computer-Aided Instruction (CAI)	56	43.25	7.95	68.80	8.20	25.55
Conventional Teaching Method	53	42.35	8.12	55.10	9.45	12.75

Table 1 showed that CAI group had a pretest mean of 43.25 (SD = 7.95) and a posttest mean of 68.80 (SD = 8.20), resulting in a mean difference of 25.55. In comparison, the Conventional Teaching Method group increased from

a pretest mean of 42.35 (SD = 8.12) to a posttest mean of 55.10 (SD = 9.45), with a mean difference of 12.75. Hence, students in both the Computer-Aided Instruction (CAI) and Conventional Teaching Method groups improved in

their performance after instruction. This implies that while both teaching methods positively affected students' performance, the Computer-Aided Instruction (CAI) strategy produced a greater improvement

in Biology performance than the conventional method, implying that it is more effective in enhancing students' academic performance. This is further depicted in figure I below.



**Figure I:** Bar Chart showing the Students' Performance Before and After Treatment

**Hypothesis 1:** There is no significant difference in the performance of students in experimental and control group before treatment.

**Table 2: t-test Analysis of Students' Performance in Experimental and Control Groups Before Treatment**

Group	N	Mean	SD	df	t	p
Computer-Aided Instruction	56	43.25	7.95	107	0.59	0.56
Conventional Teaching Method	53	42.35	8.12			

**P<0.05**

Table 3 showed that the t-value is 0.59 and p-value is 0.56. The p-value (0.56) > 0.05 level of significance. Hence, the hypothesis is not rejected. This implies that there is no significant difference in the performance of students in experimental and control group before treatment. Hence students exposed to

CAI and conventional method were homogenous at the commencement of the study.

**Hypothesis 2:** There is no significance difference in the performance of students in experimental and control group after treatment

**Table 3: t-test Analysis of Students' Performance in Experimental and Control Groups After Treatment**

Group	N	Mean	SD	df	t	p
Computer-Aided Instruction (Experimental)	56	68.80	8.20	107	8.34	0.000
Conventional Teaching Method (Control)	53	55.10	9.45			

**P<0.05**

Table 4 showed that the t-value is 8.34 and the p-value (0.000) is less than 0.05. The p-value ( $< 0.05$ ) is less than 0.05 at 0.05 level of significance. Hence, the null hypothesis is rejected. This implies that there is a significant difference in the posttest performance of students exposed to Computer-Aided Instruction (CAI) and those taught using the conventional method. Students taught with CAI performed better than those taught with the conventional method, indicating that CAI is more effective in enhancing students' performance in Biology.

### **Discussion**

The finding of the study revealed that students in both groups improved in performance, but those taught using Computer-Aided Instruction (CAI) showed greater improvement. This suggests that while traditional teaching methods still contribute positively to students' learning, the integration of technology through CAI provides a more engaging and effective learning experience. This finding is consistent with the results of Yusuf and Afolabi (2021), who reported that students exposed to CAI performed significantly better than those taught with the conventional method because of the interactive and visual nature of the instruction. It is also corroborated the finding of Ahmed and Mohammed (2023), who found that CAI enhances students' comprehension and retention of scientific concepts by promoting self-paced learning and immediate feedback. Similarly, in consonance with Alabdulkarim (2022), the present finding supports the view that computer-based tools stimulate curiosity and motivate learners to take an active role in the learning process. However, this finding contradicts the work of Adebayo and Omotayo (2020), who reported no significant difference in performance

between students taught using CAI and those taught with the conventional method, attributing this to inadequate digital infrastructure and poor teacher training. The greater improvement seen among CAI students in this study may be due to the interactive multimedia features that make abstract Biology concepts easier to visualize and understand. The implication of this result is that schools should integrate CAI into classroom instruction to foster active learning, improve student motivation, and enhance overall academic achievement in Biology.

The finding of the study revealed that there was no significant difference in performance between the groups before treatment, indicating that both groups had similar levels of understanding before the introduction of the instructional methods. This is consistent with the findings of Adegoke and Alabi (2022), who reported no significant pre-treatment difference between students exposed to computer-assisted learning and those taught traditionally. Similarly, it corroborated Yusuf and Adeoye (2021), who in their study began with comparable baseline knowledge before exposure to different teaching interventions. However, this finding contradicts that of Ibrahim and Musa (2020), who found pre-existing gaps in students' performance due to prior exposure to technology-enhanced learning in some schools. The result of this study implies that the groups were academically equivalent before treatment, ensuring that any subsequent differences in performance were likely due to the instructional strategies rather than initial disparities in ability.

The finding of the study revealed that students taught with Computer-Aided Instruction (CAI) performed significantly better than those taught using the conventional method, indicating that CAI

enhanced students' understanding and retention of Biology concepts. This result is consistent with the findings of Adeyemi and Afolabi (2021), who reported that the integration of technology in teaching science subjects led to improved academic achievement compared to traditional teaching approaches. It also corroborated by the finding of Yusuf and Aremu (2022), which revealed that CAI promotes individualized learning and active engagement, resulting in higher performance among students. Similarly, Olayinka (2023) noted that interactive computer-based learning environments stimulate curiosity and sustain students' attention, thereby improving comprehension. However, the finding contradicts the work of Ibrahim and Bello (2020), who found no significant difference in achievement between students exposed to CAI and those taught traditionally, attributing the outcome to inadequate technological infrastructure and teachers' limited digital competence. The implication of this finding is that effective use of CAI can make learning Biology more engaging and interactive, suggesting that schools should adopt computer-based instructional tools to enhance teaching efficiency and improve students' performance in science subjects.

### Conclusion

Based on the findings of the study, it can be concluded that Computer-Aided Instruction (CAI) significantly enhanced students' performance in Biology compared to the conventional teaching method. The use of CAI was effective in improving students' understanding and interest in the subject. Therefore, CAI can be considered a valuable teaching strategy for improving learning outcomes in Biology.

### Recommendations

Based on the findings, the following recommendations are made:

1. Schools should adopt Computer-Aided Instruction as part of the teaching strategy for Biology to enhance students' performance and foster positive attitudes toward the subject.
2. Biology teachers should receive regular training on the effective use of CAI to ensure proper implementation and maximize learning outcomes.
3. Schools should provide adequate computer facilities, instructional software, and technical support to facilitate the use of CAI in teaching.
4. Curriculum planners should consider incorporating technology-based instructional strategies into the Biology curriculum to improve engagement and comprehension.

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## EFFECTS OF AUDIOVISUAL TECHNOLOGY ON SENIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN BIOLOGY IN EKITI STATE.

BY

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### Abstract

*The study investigated the effects of Audiovisual Technology on the learning outcomes of Senior Secondary School students in Biology in Ekiti State. It also assessed the influence of Audiovisual Technology on students' performance and attitude compared to conventional teaching methods. A quasi-experimental research design was employed. The population comprised 12,690 SS II students from 206 public secondary schools, with a sample of 140 students selected through a multistage sampling procedure. Data were collected using the Biology Performance Test (BPT) and Students' Biology Attitudinal Scale (SBAS). The instruments were validated by experts in Biology Science Education and found reliable with coefficients of 0.87 and 0.88 respectively. The study lasted eight weeks, and data were analyzed using mean, standard deviation, and t-test at 0.05 level of significance. Findings revealed that students exposed to Audiovisual Technology significantly outperformed those taught via conventional methods in performance and attitude. It is recommended that teachers integrate Audiovisual Technology into Biology instruction to enhance active learning and promote better understanding of biological concepts.*

**Keywords:** Audiovisual tools, Learning Outcomes, Secondary School Students, Science Students

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### Introduction

Education is the bedrock of any society, serving as the foundation upon which individuals and nations build their future. It serves as a bridge for transferring knowledge, values, and skills across generations. It is a powerful tool for shaping minds, promoting critical thinking, and driving national development. Ayeni (2020) highlighted that education came into existence through the agitations from societal beliefs, needs and values. The national goals of education in Nigeria according to the National Policy on Education (NPE, 2014) include the building of a free and democratic society, a just and egalitarian society, a united, strong, and

self-reliant nation, a great and dynamic economy, and a land full of bright opportunities for all citizens. In line with the Nigerian philosophy of education, it is believed that education is an instrument for national development. Consequently, the formulation of ideas, the education for national development, and the interaction of persons and ideas are all essential aspects of education. These components collectively improve the worth and development of the individual, ensuring that every citizen contributes meaningfully to the growth and progress of the nation. Education, therefore, is not only a tool for intellectual development but also a

catalyst for shaping responsible, productive, and patriotic citizens.

One of the most critical aspects of education is scientific knowledge, which is fundamental to modern development. Science equips individuals with the ability to understand, manage, and efficiently utilize the natural environment's resources. Ayeni (2020) explained, science has become such an indispensable tool that no nation, developed or developing can afford to relegate its study in schools. Science emphasizes evidence-based decision-making, relying on empirical data and rigorous experimentation. In this era of misinformation and fake news, science provides a credible and objective source of knowledge that informs public policy, regulations, and individual choices. Science education, therefore, involves not just the content knowledge of subjects like Biology, Chemistry, and Physics, but also the use of effective teaching methods that make scientific knowledge accessible and meaningful to students. When taught properly, science helps students develop skills to analyze, evaluate, and apply knowledge in solving real-life problems, making them better equipped to contribute positively to their communities and the larger society.

Biology, as a branch of science, focuses on the study of living organisms and their interactions with the environment, from molecular mechanisms within cells to the behaviors of entire ecosystems. Nwuba, Egwu, Awosika, and Osuafor (2022) defined biology as the branch of science that studies plants and animals in their environment. Biology

encompasses a vast range of topics, from molecular mechanisms within cells to interactions within ecosystems (Campbell et al., 2022). However, certain concepts within the biology curriculum are perceived as abstract and challenging by students. For instance, Etobro and Fabinu (2017) identified topics such as nutrient cycling in nature, ecological management, and conservation of natural resources, pests and diseases of crops, and the reproductive system in plants as particularly difficult for senior secondary school students in Lagos State. This and other similar findings highlight the need for innovative instructional strategies to enhance the teaching and learning of complex biological concepts.

Also, the need for effective Biology education in Nigeria is very important and so demands considerable attention. One of the major issues that bother Biology students in Nigeria is their academic performance. Poor academic performance of students in internal and external examinations is a reflection of the problems and challenges facing the educational system in Nigeria (Bichi, 2019). Due to the complex nature of Biology as a subject, students seem to have difficulties in learning and understanding basic concepts and their alternative conceptions which seems to be part of the causes of poor academic performance in Biology. The results of the West African Senior School Certificate Examination (WASSCE) from 2019 to 2023 in Ekiti State, as shown in the table below, clearly demonstrate the performance of students in this subject.

**Table 1: Students' Performance in Biology in WASSCE between 2019 and 2023**

Year of Exam	Total No. of Candidates	A1-B3	%	C4-C6	%	D7-E8	%	F9	%	% Pass	% Fail
2019	6691	744	11	3200	48	1657	25	1060	16	58	41
2020	6022	1622	27	3108	52	668	11	624	10	79	21

2021	5641	1120	20	3333	59	761	13	427	8	79	21
2022	2499	491	20	1509	60	185	7	314	13	80	20
2023	5563	824	15	3098	56	1069	19	572	10	71	29

Source: Ministry of Education, Planning, Research and Statistics Department, Ekiti State (2024)

Table 1 highlights a concerning trend in the West African Senior School Certificate Examination (WASSCE) Biology results in Ekiti State from 2019 to 2023. While the overall performance appears somewhat promising, a closer analysis reveals a fluctuating pattern. Only a small percentage of students ranging from 12% to 27% scored between A1 and B3. Although a significant number of students achieved credit passes (C4, C5, and C6), the percentage of students scoring D7 and E8—though lower—still indicates gaps in the mastery of the subject. These days, most university admission requires an aggregate grade between A1 and B3 for Biology, and going by the analysis of the results presented in Table 1, it implies that many of these students would not qualify for admission due to their grade as a greater percentage of these students had credit passes. This suggests that a majority of students struggle with understanding Biology, possibly due to ineffective teaching methodologies, which remains a major challenge in education. Furthermore, the inconsistency in failure rates over the years highlights the need for improved instructional strategies and stronger student support systems to enhance learning outcomes and academic performance.

One effective approach to improving Biology instruction is the integration of audiovisual technology, which enhances comprehension by combining visual and auditory stimuli to reinforce learning. Audiovisual materials such as animations, instructional videos, and interactive simulations actively engage learners by stimulating both sight and hearing, thereby making learning experiences more dynamic and memorable. These tools play a crucial role in capturing and sustaining students' interest, improving

their attitudes toward Biology, and fostering deeper understanding of complex and abstract concepts. Kassa, Azene, Mengstie, and Ferede (2024) reported that the use of multimedia and dynamic classroom-integrated instruction significantly improves students' academic achievement in Biology by simplifying abstract ideas and promoting interactivity. Similarly, Ibe and Abamuche (2019) emphasized that the incorporation of audiovisual technology transforms students' learning experiences by making abstract concepts more concrete and engaging, thereby enhancing student participation and achievement. These findings underscore the importance of adopting modern instructional strategies not only to improve academic outcomes but also to stimulate long-term interest in Biology. Through the effective use of audiovisual technology, teachers can create immersive learning environments that promote meaningful understanding and long-term retention.

Students' attitudes toward Biology constitute another critical factor influencing learning outcomes. Attitude is often shaped by prior learning experiences, the availability of instructional resources, and the teaching methods employed in the classroom. Many students develop negative perceptions of Biology due to challenges such as complex terminologies, difficulty in visualizing biological structures, and the lack of practical demonstrations. Ahmed (2025) suggests that students' attitudes toward science are influenced by teaching methods, availability of instructional resources, and prior experience with the subject. When instruction relies solely on textbook explanations without the use of visual or interactive aids, Biology is often perceived as abstract and difficult. Audiovisual technology can address these challenges by bringing biological

processes and structures to life, thereby making learning more relatable and accessible. In support of this view, Olusola-Fadumiye and Aderemi (2024) found that engaging learning environments significantly influence students' participation and academic performance. The adoption of audiovisual instructional strategies can therefore foster positive attitudes toward Biology by creating dynamic classroom environments that encourage curiosity and enthusiasm.

The persistent challenges in students' performance are further corroborated by the Chief WAEC examiners' reports for 2022 and 2023. The 2022 report indicated that candidates experienced difficulties in defining biological terms, explaining key concepts such as transpiration, and drawing or labeling diagrams accurately. These weaknesses point to inadequate conceptual understanding and poor visualization skills. Similarly, the 2023 report identified problems such as incorrect spelling of biological terms, poor interpretation of examination questions, difficulty in solving

genetic problems like Punnett squares, confusion between somatic and reproductive cells, and challenges in organism classification. These recurring weaknesses suggest that many students struggle with both theoretical understanding and practical application of biological knowledge.

Given the persistent poor performance in Biology in Ekiti State, there is a compelling need to investigate instructional approaches that can enhance students' learning outcomes. The integration of audiovisual technology into Biology teaching holds considerable promise for improving students' academic performance and attitudes toward the subject. By presenting biological concepts through videos, animations, and other multimedia resources, audiovisual technology can bridge the gap between abstract ideas and real-life applications, thereby making learning more meaningful and effective. This study therefore seeks to examine the effects of audiovisual technology on the learning outcomes of senior secondary school Biology students in Ekiti State, with particular emphasis on academic performance and attitude toward learning Biology.

### **Purpose of the Study**

The purpose of this study is to examine the effects of audiovisual technology on the learning outcomes of biology students in Ekiti State. Specifically, the study aims to:

1. determine the performance of senior secondary school students in Biology with the use of audiovisual technology.
2. determine the effects of audiovisual technology on students' attitude towards Biology.

### **Research Questions**

The following research questions were raised to guide the study:

1. What is the impact of audiovisual technology on students' performance in Biology?

2. What is the influence of audiovisual technology on students' attitude toward Biology?

### **Research Hypotheses**

The following null research hypotheses were formulated in this study:

1. There is no significant difference in the pre-test performance of students in the experimental and control groups.
2. There is no significant difference in the post-test performance of students in Biology in the experimental and control groups.
3. There is no significant difference in the pre-attitudes of students in the experimental and control groups.

4. There is no significant difference in the attitude of students exposed to audiovisual technology and those exposed to conventional method in Biology.

## METHODOLOGY

The study employed pre-test and post-test quasi experimental design. The population of the study consisted of all 12, 690 Senior Secondary School two (SSS II) Biology students in all the 206 public Secondary Schools in Ekiti State. The sample for the study was 140 SSS II Biology students selected through multistage sampling procedure. The first stage involved the selection of one senatorial district from the state through simple random sampling technique. The second stage involved the selection of two Local Government Areas from the selected senatorial district using simple random sampling technique. The third stage involved the selection of two public senior secondary schools from each of the selected Local Government Areas using stratified sampling technique (based on location) and purposive sampling technique for the selection of two public senior secondary schools from the selected four public schools that have audiovisual technology tools.

The two research instruments used for this study, namely: "Biology Performance Test" (BPT) and "Students Biology Attitudinal Scale" (SBAS) were designed by the researcher. The instruments were validated for face and content validity by lecturers in Science Education (Biology), Tests, Measurement and Evaluation experts within Faculty of Education, Ekiti State University, Ado-Ekiti, and experienced WAEC examiners. The reliability of the instrument was determined through test re-test reliability method. The scores obtained for BPT

were analyzed using Pearson's Product Moment Correlation, which yielded a reliability coefficient of 0.87. The internal consistency of the Student Biology Attitudinal Scale was determined using Cronbach's Alpha, which produced a coefficient of 0.88 at the 0.05 level of significance. Based on the consistency of these results, the instruments were considered reliable for the study.

Audiovisual Technology instructional package for the experimental group included lesson plans, Audiovisual Technology tools, practical demonstrations, and assessment tools designed to guide teachers in integrating Audiovisual Technology into classroom instruction. The control group was taught using conventional method. The research procedure were in three stages; pre-treatment stage (one week), the Biology Performance Test (BPT) and Students Biology Attitudinal Scale (SBAS) were administered, the treatment stage (six weeks), the experimental group were taught using Audiovisual Technology while the conventional group were taught without Audiovisual Technology, and the post-treatment stage (one week), the same Biology Performance Test (BPT) and Students Biology Attitudinal Scale (SBAS) were administered. Eight weeks were used altogether for the whole study. Data collected were analyzed using descriptive statistics such as means, standard deviation, and bar-chart to answer the research questions while inferential statistics of t-test was used to test the hypotheses. All the hypotheses generated were tested at 0.05 level of significance.

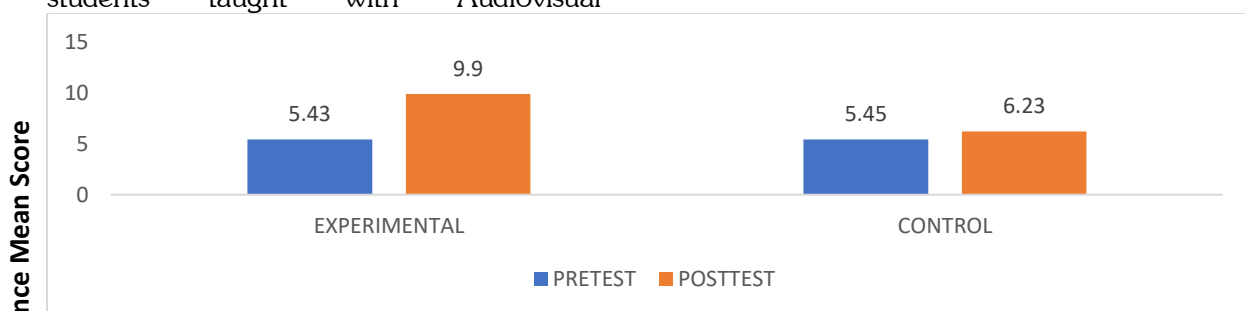
**Research Question 1:** What is the impact of audiovisual technology on students' performance in Biology?

**Table 2:** Performance Mean Scores and Standard Deviation of Students in Experimental and Control Groups Respectively

Group	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Experimental	69	5.43	1.93	9.90	1.926	4.47
Control	71	5.45	1.96	6.23	2.514	0.78

Table 2 shows the mean and standard deviation of the performance mean scores of students exposed to Audiovisual Technology and conventional methods of teaching Biology before and after treatment. Information contained in Table 2 shows that students in the experimental and control groups had pretest mean scores of 5.43 and 5.45 and standard deviation of 1.93 and 1.96 respectively prior to treatment. It appears that the groups are homogenous prior to the treatment. On exposure to treatment, students taught with Audiovisual

Technology had the higher posttest mean score of 9.90 with a standard deviation of 1.93, while those students in the control group had posttest mean score of 6.23 with a standard deviation of 2.51. This implies that the use of Audiovisual Technology appears to be more effective than the conventional method in enhancing the performance of students in Biology. Students' performance in Biology before and after treatment is represented in Figure i



**Figure i:** Bar Chart Representation of Performance Mean Scores of Students in Experimental and Control Groups Respectively.

**Research Question 2:** What is the influence of Audiovisual Technology on students' attitude toward Biology?

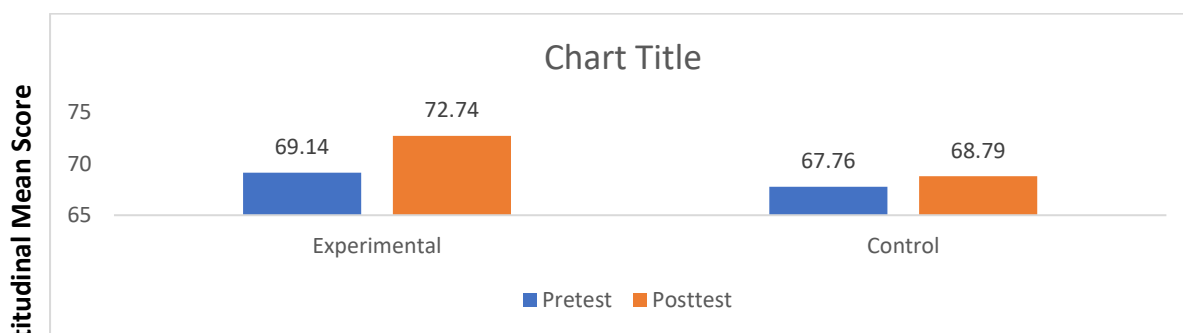
**Table 3:** Attitudinal Mean Scores and Standard Deviation of Students in Experimental and Control Groups Respectively.

Group	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Experimental	69	69.14	7.64	72.74	4.81	3.60
Control	71	67.76	7.56	68.79	9.53	1.03

Table 3 shows the mean and standard deviation of students' attitudinal mean scores exposed to Audiovisual Technology and conventional method of teaching Biology before and after treatment. Prior to treatment, results in Table 3 show that students in the experimental and control groups had pre-attitudinal mean scores of 69.14 and 67.76 with standard deviation of 7.64 and 7.56 respectively. After exposure to treatment, students exposed to Audiovisual Technology recorded a higher post-attitudinal mean score of 72.74 with a standard deviation of 4.81, while students in the control

group had a post-attitudinal mean score of 68.79 and a standard deviation of 9.53. The mean gain scores indicate that the experimental group achieved a greater improvement in the attitude (mean gain = 3.60) compared to the control group (mean gain = 1.03). This signifies that Audiovisual Technology was more effective in improving students' attitudes towards Biology than the conventional method used in the control group. Students' attitude towards Biology before and after treatment is represented in Figure ii.

**Figure ii:** Bar Chart Representation of Attitudinal Mean Scores of Students in Experimental and Control Groups Respectively



### Testing of Hypotheses

**Hypothesis 1:** There is no significant difference in the pre-test performance of students in the experimental and control groups respectively.

**Table 5:** t-test summary of Pretest Mean Scores of Students in Experimental and Control Groups Respectively.

<i>Experimental</i>	69	5.43	1.96	138	-0.48	0.961
<i>Control</i>	71	5.45	1.93			

$p > 0.05$  (Not Significant)

Table 4 presents the paired sample t-test comparing the academic performance of students in the experimental group and the conventional group before the treatment in Biology. It shows that ( $t_{138} = -0.48, p > 0.05$ ). Since the p-value is greater than 0.05, the hypothesis is not rejected. This implies that there is no significant difference in the pre-test mean scores of students in experimental and control groups. This shows that the

two groups were homogeneous at the commencement of the experiment.

**Hypothesis 2:** There is no significant difference in the post-test performance of students in Biology in the experimental and control groups. To test Hypothesis 2, posttest mean scores of students in experimental and control groups were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table

**Table 5:** t-test summary of Post-test Mean Scores of Students in Experimental Control Groups

Group	N	Mean	SD	Df	T	P
<i>Experimental</i>	69	9.90	1.93	138	9.685	0.000
<i>Control</i>	71	6.23	2.51			

$p < 0.05$  (Significant result)

Table 6 presents the paired sample t-test comparing the academic performance of students in the experimental group and the conventional group after treatment in Biology. The result above shows that ( $t_{138} = 9.685, p < 0.05$ ). Since the p-value is less than 0.05, the hypothesis is rejected. This indicates that there is a significant difference in the performance mean scores of students in the experimental and control groups after treatment. It further shows that students

in the experimental group performed better than those in the control group.

**Hypothesis 3:** There is no significant difference in the pre-attitudes of students in the experimental and control groups. To test Hypothesis 3, pre-attitudinal mean scores of students in the experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 7.

**Table 6:** t-test summary of Pre-Attitudinal Mean Scores of Students in Experimental and Control Groups Respectively.

<i>Group</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>df</i>	<i>T</i>	<i>P</i>
<i>Experimental</i>	69	69.14	7.64	138	1.078	0.283
<i>Control</i>	71	67.76	7.56			

$p > 0.05$  (Not Significant)

The result in Table 7 shows the paired sample t-test comparing the attitudinal mean scores of students in the experimental group and the conventional group before treatment in Biology which shows that ( $t_{138} = 1.078$ ,  $p > 0.05$ ). Since the p-value is greater than 0.05, the null hypothesis was not rejected. This indicated that there is no significant difference in the pre-attitudinal mean scores of students in the experimental

and control groups. In other words, the two groups began the study with the similar level of attitude, showing that their attitudes were the same at the commencement of the study.

**Hypothesis 4:** There is no significant difference in the attitude of students exposed to audiovisual technology and those exposed to conventional methods in Biology.

**Table 7:** t-test summary of Post-Attitudinal Mean Scores of Students in Experimental and Control Groups Respectively.

<i>Group</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>Df</i>	<i>T</i>	<i>P</i>
<i>Experimental</i>	69	72.74	4.81	138	2.528	0.013
<i>Control</i>	71	68.79	9.53			

$p < 0.05$  (Significant result)

The result in Table 8 shows that ( $t_{138} = 2.528$ ,  $p < 0.05$ ). Since the p-value is less than 0.05, the hypothesis is rejected. This indicated that there is a significant difference in the post-attitudinal mean scores of students in the experimental and control groups. This implies that the treatment had a positive effect on the attitude of students in the experimental group compared to those in the control group.

### **Discussion**

Findings from this study indicated that both the control and experimental groups had similar low performance levels in the pretest. This suggests that both groups were homogeneous at the commencement of the experiment which the researcher believes might be linked to the general ineffectiveness of the traditional teaching methods often used in science classes, including Biology. As a result, any notable difference observed later can be attributed to the specific interventions applied, rather than mere chance.

The findings further revealed that students taught Biology using Audiovisual Technology performed significantly better than those taught using the conventional method. This suggests that the use of Audiovisual Technology was effective in enhancing students' academic performance in Biology at the secondary school level. This result aligns with the findings of Asuzu and Okoli (2019), who reported that students exposed to multimedia-integrated instruction outperformed their counterparts taught through traditional approaches. Their study also emphasized the need for increased teacher training and stronger government support to promote the use of multimedia resources in science classrooms.

It is noteworthy, however, that there was no significant difference in the pre-attitudinal scores of students in the experimental and control groups, indicating that both groups commenced the study with similar attitudes toward Biology.

However, the significant difference observed in the post-attitudinal scores after the treatment highlights the effectiveness of Audiovisual Technology in improving students' attitudes toward the subject. This improvement may be attributed to the use of audiovisual instructional materials, which made Biology lessons more concrete, engaging, and easier to understand, thereby stimulating students' interest and positive disposition toward learning Biology compared to the conventional teaching approach. This finding is in line with the study of Olu-Ajayi (2016), who reported that the use of audio-visual aids in Biology instruction significantly enhanced students' learning outcomes and interest in Biology, particularly among senior secondary school students.

Retention of knowledge is a critical indicator of effective learning. The study showed a significant difference in retention scores between the experimental and control groups, with students exposed to Audiovisual Technology demonstrating higher retention of Biology concepts. This supports the assertion that multimedia learning enhances memory retention by engaging multiple senses, reinforcing learning through visual and auditory channels, and promoting active cognitive processing (Mayer, 2017).

Overall, the findings of this study indicated that Audiovisual Technology significantly enhances students' performance, attitude, and retention in Biology. The results provide strong empirical support for integrating Audiovisual Technology into the teaching of Biology in secondary schools, especially in contexts where conventional teaching methods have shown limited effectiveness.

### **Recommendations**

Based on the findings of the study, the following recommendations were made:

1. Biology teachers should be equipped with audiovisual gadgets and adequately trained to implement Audiovisual

Technology effectively, to improve students' learning outcomes.

2. Educational policymakers and school administrators should support the integration of Audiovisual Technology in

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# OPERATIONAL RISKS AND MECHANICAL CONSEQUENCES OF REPLACING HYDRAULIC FLUID WITH WATER IN COMMERCIAL VEHICLE BRAKE SYSTEMS

BY

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## Abstract

*The use of water as a substitute for hydraulic brake fluid among commercial vehicle operators has become a common but unsafe practice in many developing transportation systems. This study investigated the operational risks and mechanical consequences associated with replacing standard hydraulic brake fluid with water in commercial vehicle brake systems. A descriptive survey and mechanical inspection approach were adopted. Data were collected from 150 commercial vehicle operators and 40 auto-mechanics using structured questionnaires and brake system condition checklists. The findings revealed that water substitution significantly increased brake system corrosion, seal deterioration, reduced braking efficiency, and brake failure incidents. Additionally, operators who regularly used water reported higher accident rates and frequent maintenance breakdowns. The study concludes that the continued use of water in hydraulic brake systems poses severe safety hazards and mechanical damage risks. It recommended that transport authorities should enforce regular brake system inspections, Driver's sensitization programs should emphasize proper brake maintenance, subsidized or affordable brake fluid distribution should be encouraged, auto-mechanics should be trained on preventive maintenance practices and policy regulations should penalize unsafe maintenance behaviors.*

**Keywords:** Hydraulic brakes, brake fluid substitution, water contamination, vehicle safety, mechanical failure, commercial transport.

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## Introduction

The hydraulic brake systems in vehicles play a critical role in ensuring vehicle safety by transmitting force from the brake pedal to wheel braking mechanisms using incompressible hydraulic fluid. Standard brake fluids are specially formulated to withstand high temperatures, prevent corrosion, and maintain consistent pressure transmission (Terzo-Tech, 2024). However, in many commercial transport operations, especially in developing countries like Nigeria, operators often replace hydraulic brake fluid with water due to cost constraints, limited availability, or lack of

technical awareness. Hydraulic brake systems are fundamental to vehicle safety, as they enable controlled deceleration by transmitting pedal force through incompressible brake fluid to wheel braking components (Sarkan et al. (2025). Modern brake fluids are chemically engineered to resist high operating temperatures, inhibit corrosion, maintain stable viscosity, and ensure consistent pressure transmission under extreme mechanical loads (Mladenov et al., 2025). However, improper maintenance practices, particularly among commercial vehicle operators in developing economies, have resulted in

widespread misuse and substitution of recommended brake fluids.

Brake fluid contamination and degradation is a major threat to braking reliability. Studies have shown that brake fluids are hygroscopic, meaning they absorb moisture from the atmosphere over time, leading to reduced boiling points and vapor lock formation (Tseng & Lin, 2024). Vapor lock reduces hydraulic pressure transmission and significantly increases stopping distance, especially during prolonged braking operations. Šarkan et al. (2025) reported that brake fluid moisture content exceeding 3% can lower wet boiling point values by more than 40%, drastically compromising braking effectiveness.

The substitution or addition of water compromises brake system integrity because water has a lower boiling point and promotes internal corrosion (Heisler, 2014). Brake fluid contamination or substitution has been linked to vapor lock, seal degradation, reduced braking response, and catastrophic brake failure (Gillespie, 2018). Despite these risks, the practice remains widespread among informal commercial vehicle operators. Beyond passive moisture absorption, deliberate substitution of hydraulic brake fluid with water has been observed among commercial vehicle operators due to cost constraints, lack of technical awareness, and limited regulatory enforcement (Bako et al., 2019). Unlike engineered brake fluids, water lacks corrosion inhibitors and thermal stability properties. The introduction of water into brake systems accelerates internal rust formation, seal degradation, and sludge accumulation, thereby increasing mechanical failure risk (Terzo-Tech, 2024).

The road traffic safety statistics indicated that mechanical defects contribute significantly to commercial vehicle accidents in low-income countries (World Health Organization [WHO], 2023). Brake-related failures remain among the leading causes of vehicle breakdowns and accident occurrences. Despite the seriousness of this issue, empirical studies focusing specifically on intentional water substitution in brake systems remain limited. This study therefore seeks to fill

this knowledge gap by systematically examining the operational risks and mechanical consequences of replacing hydraulic brake fluid with water among commercial vehicle operators.

In Nigeria for instance, road traffic accidents related to brake failure remain a major public safety concern. According to World Health Organization reports, mechanical defects contribute significantly to transport-related fatalities in low-income countries (WHO, 2022). Understanding the operational and mechanical impacts of water substitution is essential for developing effective safety interventions.

This study therefore examined the operational risks and mechanical consequences associated with replacing hydraulic brake fluid with water among commercial vehicle operators because many commercial vehicle operators engage in unsafe vehicle maintenance practices, including the use of water instead of recommended brake fluid. This practice has resulted in frequent brake failures, increased accident rates, higher maintenance costs, and reduced vehicle lifespan. This study therefore seeks to fill this gap by systematically examining the risks and consequences associated with water substitution in hydraulic brake systems, hence the main objective of this study is to assess the operational risks and mechanical consequences of replacing hydraulic fluid with water in commercial vehicle brake systems.

### **Research Questions**

The following research questions were used to guide the study.

1. How prevalent is the use of water as a substitute for brake fluid among commercial vehicle operators in Adamawa State?
2. What mechanical damages result from using water in hydraulic brake systems in Adamawa State?
3. How does water substitution affect braking efficiency and safety performance of vehicles in Adamawa State?
4. What are the operational risks that are associated with substituting brake fluid with water?

## Research Hypotheses

The following null hypotheses were tested at 0.05 significance level:

H<sub>01</sub>: There is no significant association in braking performance of vehicles that uses standard hydraulic brake fluid and those using water as a substitute.

H<sub>02</sub>: There is no significant association in mechanical deterioration of vehicles using standard brake fluid and those using water in the brake system.

## Literature Review

### Hydraulic Brake System Operation

Hydraulic brake systems rely on incompressible brake fluid to transmit force evenly through brake lines to wheel cylinders or calipers (Terzo-Tech (2024). Brake fluids are designed to resist high operating temperatures, prevent corrosion, and lubricate internal components. Brake fluid performance is primarily determined by boiling point, viscosity stability, and resistance to oxidation (Khare and Sharma 2020). Under heavy braking conditions, brake system temperatures may exceed 200°C, requiring fluids with high thermal tolerance. Mladenov et al. (2025) demonstrated that brake fluids with elevated moisture content experience early vaporization, leading to pressure loss and brake fade. Their experimental results confirmed that fluid degradation significantly increases stopping distance and braking instability.

### Properties of Brake Fluid

Brake fluids have high boiling points, anti-corrosion additives, and stable viscosity across temperature ranges (Heisler, 2014). Water, in contrast, boils at lower temperatures and lacks corrosion inhibitors. When exposed to high braking temperatures, water vaporizes easily, creating air pockets that reduce braking pressure (Gillespie, 2018).

### Mechanical Effects of Water in Brake Systems

A field study conducted by Tseng and Lin (2024) on brake fluid samples from commercial vehicles, they found a strong correlation between moisture accumulation and turbidity increase. The study revealed that older vehicles exhibited higher moisture concentrations and reduced boiling points. Similarly, Terzo-Tech (2024) reported that moisture contamination accelerates corrosion of

copper brake lines and steel components, causing structural weakening and fluid leakage. Water causes rust formation in master cylinders, brake lines, and calipers. It accelerates rubber seal degradation and promotes sediment buildup (Khare & Sharma, 2020). These effects reduce system reliability and increase maintenance frequency.

### Safety Implications of Brake Failure

Brake failure is a major contributor to road traffic accidents. WHO (2022) reported that mechanical faults account for a substantial proportion of fatal crashes in developing regions. Reduced braking efficiency increases stopping distance and collision risk, especially in high-speed commercial operations. The WHO (2023) reported that mechanical failures account for approximately 12%–18% of fatal commercial vehicle accidents globally, with brake system defects being a major contributor. Gillespie (2018) emphasized that braking inefficiency directly affects reaction distance, stopping time, and collision severity. These findings highlight the urgent need to address unsafe maintenance practices such as water substitution in brake systems.

Empirical research by Khare and Sharma (2020) found that improper maintenance practices accounted for over 45% of brake system failures in commercial vehicle fleets. Their findings indicated that corrosion buildup, seal deterioration, and sludge formation were strongly associated with contaminated or improperly substituted brake fluids. Bako et al. (2019) further observed that poor brake maintenance culture among Nigerian commercial drivers contributed significantly to increased accident involvement.

### Methodology

A descriptive survey and mechanical inspection research design was adopted for the study and

the population consisted of commercial vehicle operators and auto-mechanics within selected transport parks and workshops in Jimeta metropolitan city. A total of 150 commercial drivers and 40 auto-mechanics were selected using stratified random sampling to ensure representation across vehicle categories.

Data were collected for the study using structured questionnaires for drivers and mechanics, brake system inspection checklist and interview guide for maintenance practices. Quantitative data were analyzed using descriptive statistics (frequencies, percentages, and mean scores), while qualitative responses were thematically analyzed while chi-square was used to test hypothesis.

**Table 1 Frequency of Water Use as Brake Fluid Substitute**

Response Option	Frequency	Percentage (%)
Always	38	25.3
Sometimes	55	36.7
Rarely	18	12.0
Never	39	26.0
<b>Total</b>	<b>150</b>	<b>100</b>

The results on table 1 indicated that approximately 62% of surveyed operators admitted to using water at least once as a brake fluid substitute. This supports earlier findings by Khare and Sharma (2020) on improper maintenance practices in commercial transport. The findings of this study revealed a high prevalence of water substitution in hydraulic brake systems among commercial vehicle operators. More than sixty percent of the respondents admitted to using water either regularly or occasionally in place of standard brake fluid. This high rate of unsafe maintenance practice reflects limited technical awareness, financial constraints, and inadequate regulatory enforcement within the commercial transport sector. This result also aligns with the observations of Bako et al. (2019), who reported that poor vehicle maintenance culture remains widespread among

**Table 2: Observed Mechanical Damages in Vehicles Using Water**

Type of Damage	Frequency	Percentage (%)
Corrosion in brake lines	32	80.0
Rubber seal deterioration	29	72.5
Master cylinder blockage	24	60.0
Caliper or wheel cylinder rust	27	67.5
Brake fluid contamination	35	87.5

(n = 40 mechanics) respondents

Table 2 shows that 87.5% of inspected vehicles exhibited brake fluid contamination, while 80% experienced brake line corrosion. This confirms that water substitution significantly accelerates mechanical degradation of brake components and aligns with Heisler's (2014) assertion that water accelerates

## Results and Discussion

**Research Question 1:** How prevalent is the use of water as a substitute for brake fluid among commercial vehicle operators in Adamawa State?

commercial drivers in Nigeria, with many operators resorting to improvised solutions to reduce operational costs. Similarly, Khare and Sharma (2020) found that a significant proportion of brake system failures in commercial fleets were linked to improper fluid handling and maintenance abuse. The high prevalence recorded in this study further supports the argument that economic pressure and limited access to quality maintenance resources continue to drive risky operational behaviors. Without targeted intervention and education programs, the practice of water substitution is likely to persist, thereby increasing mechanical failure rates and accident risks.

**Research Question 2:** What mechanical damages result from using water in hydraulic brake systems in Adamawa State?

internal brake system degradation. The mechanical inspection results demonstrated widespread deterioration of brake components in vehicles that used water as a substitute for hydraulic fluid. Common defects included brake line corrosion, rubber seal degradation, master cylinder blockage, and sludge formation.

These mechanical failures compromise system integrity and reduce braking reliability.

These findings also strongly agree with the findings of Terzo-Tech (2024), which showed that moisture contamination accelerates oxidation of metal components and weakens copper and steel brake lines. Additionally, Tseng and Lin (2024) reported that increased moisture content in brake fluid is associated with turbidity buildup and sediment formation, both of which obstruct fluid flow and impair pressure transmission. Furthermore, Mladenov et al. (2025) experimentally confirmed that moisture presence significantly alters brake fluid chemical properties, leading

to early thermal degradation and increased internal corrosion. When compared with these studies, the present research demonstrates that deliberate substitution with water introduces even greater mechanical stress than passive moisture absorption, due to the complete absence of corrosion inhibitors and stabilizing additives. The high frequency of mechanical defects observed in this study highlights the long-term cost implications of water substitution, as frequent repairs, component replacements, and premature system failure increase overall maintenance expenses for vehicle operators.

**Research Question 3:** How does water substitution affect braking efficiency and safety performance of vehicles in Adamawa State?

**Table 3: Mean Summary on Using Water on Braking Efficiency**

Statement	Mean Score	Decision
Water reduces braking response time	3.42	Agree
Water increases stopping distance	3.35	Agree
Water causes brake fade during heavy use	3.28	Agree
Water contributes to sudden brake failure	3.47	Agree
Water reduces overall braking efficiency	3.51	Agree

The data in table 3 indicated that all mean values exceeded the acceptance threshold of 2.50, indicating strong agreement among respondents that water negatively affects braking performance. The highest mean score (3.51) shows that drivers perceived a major reduction in overall braking efficiency. Drivers reported reduced braking response, frequent brake fade, and longer stopping distances. About 38% of respondents experienced brake-related near-miss incidents. This confirms WHO (2022) findings on mechanical defects contributing to road accidents. The analysis revealed that vehicles using water experienced significantly reduced braking efficiency, delayed pedal response, increased stopping distance, and higher occurrences of brake fade. A substantial proportion of drivers also reported near-miss incidents and brake-related accidents. These findings are consistent with the work of Šarkan et al. (2025), who demonstrated that brake fluid moisture levels exceeding safe thresholds drastically reduce wet boiling points, increasing

vapor formation and pressure instability. Similarly, Gillespie (2018) emphasized that hydraulic brake system efficiency depends heavily on fluid thermal stability and incompressibility, both of which are compromised when water is introduced into the system.

This study further supports the WHO (2023) report, which identified mechanical failures particularly brake system defects — as major contributors to commercial vehicle accidents in low-income countries. The strong statistical relationship found between water substitution and reduced braking performance in this study confirms that improper brake fluid practices directly threaten road safety and public welfare. This evidence reinforces the urgent need for improved regulatory oversight and technical training programs aimed at commercial drivers and workshop operators.

**Research Question 4:** What are the operational risks that are associated with substituting brake fluid with water?

**Table 4: Operational Risk Reported by Drivers**

Risk Factor	Frequency	Percentage (%)
Brake pedal softness	64	42.7
Delayed braking response	58	38.7
Frequent brake repairs	71	47.3
Near-miss accidents	44	29.3
Complete brake failure experience	36	24.0

(Multiple responses allowed)

The result show that 47.3% of drivers experienced frequent brake repairs, while 29.3% reported near-miss accidents related to brake malfunction. This demonstrates the serious operational risks associated with water substitution. Mechanics indicated that vehicles using water required more frequent brake overhauls and part replacements, increasing long-term maintenance costs. Operational risks identified in this study included frequent brake breakdowns, increased maintenance frequency, vehicle downtime, unpredictable braking behavior, and heightened accident exposure. Drivers reported experiencing soft brake pedals, delayed response under heavy load conditions, and inconsistent braking pressure during long-distance operations. These operational risk correspond with the findings of Khare and Sharma (2020), who reported that brake system

failures contribute to operational inefficiencies, service interruptions, and higher fleet operating costs. Tseng and Lin (2024) also observed that degraded brake fluid conditions reduce system reliability, especially in high-mileage commercial vehicles. These findings demonstrate that water substitution not only compromises mechanical integrity but also disrupts transport service efficiency. Frequent vehicle downtime affects income generation for drivers and transport companies while simultaneously increasing safety risks for passengers and road users.

**Hypothesis 1.**

Chi-square ( $\chi^2$ ) test was used to examine associations between brake fluid type and operational performance indicators.

**Table 5: Chi-Square Analysis of Brake Fluid Type and Braking Performance**

Performance Category	Standard Fluid	Water Substitute	Total
Normal braking	52	21	73
Delayed response	8	45	53
Brake failure tendency	0	24	24
<b>Total</b>	<b>60</b>	<b>90</b>	<b>150</b>

$\chi^2$  calculated = 68.42

df = 2

Critical value = 5.99

p < .05

Since the calculated chi-square value (68.42) is greater than the critical value (5.99),  $H_{01}$  is rejected. This has clearly shown that there is a statistically significant association in braking

performance between vehicles using water and those using standard hydraulic brake fluid. Water substitution significantly reduces braking efficiency and response time.

**Hypothesis 2****Table 6: Chi-Square Analysis of Brake Fluid Type and Mechanical Deterioration**

Mechanical Condition	Standard Fluid	Water Substitute	Total
Low deterioration	44	19	63
Moderate deterioration	11	33	44
Severe deterioration	5	38	43
<b>Total</b>	<b>60</b>	<b>90</b>	<b>150</b>

$\chi^2$  calculated = 54.17

df = 2

Critical value = 5.99

$p < .05$

Since  $\chi^2$  calculated is greater than  $\chi^2$  critical,  $H_{02}$  is rejected. This means that there is a significant association between water substitution and increased mechanical deterioration of brake components.

### Conclusion

The study established that using water in place of hydraulic brake fluid significantly increases operational risks and mechanical damage in commercial vehicle brake systems. The practice leads to corrosion, component failure, reduced braking efficiency, and heightened accident risk. Continued usage of water in brake systems threatens both vehicle lifespan and public road safety.

### Recommendations

Based on the findings of the study, the following recommendations were made

1. Transport authorities should enforce regular brake system inspections on vehicle operators
2. Driver sensitization programs should emphasize proper brake maintenance all the time
3. Subsidized or affordable brake fluid distribution should be encouraged among vehicle operators
4. Auto-mechanics should be trained on preventive maintenance practices on brake systems.
5. Policy regulations should penalize unsafe maintenance behaviors among vehicle operators.

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## ROBOTIC ENGINEERING: AN AI TIMED BOMB OR A BUDDING BLESSING FOR HUMAN RACE - A CRITICAL PERFORMANCE APPRAISAL AND REVIEW

BY

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### Abstract

Robotic Engineering products have proliferated our modern world in unprecedented ways in many forms: humanoids, drones, automated guided vehicles (AGVs), delivery bots, dancing bots, surgical robots, robotic vacuum cleaners, telepresence, among others. This study examined the impacts of Robotic Engineering products on human race and activities using descriptive survey design. Responses from 401 participants engaged with robotics were analysed to assess the perceived benefits or otherwise of artificial intelligence (AI) powered robotic engineering across various sectors. Associated risks, ethical challenges, potential societal impacts and public perception of AI-driven robotic technologies were examined. Result showed that robotic engineering had increased efficiency and precision in key sectors such as healthcare, manufacturing, defense, logistics, and domestic services. However, there are issues like responsibility, human skill loss, anxieties and social injustice. Consequently, whether robotic engineering will be a **budding blessing** (if guided by ethical governance, responsible innovation, and proactive policies) or a disruptive **AI timed bomb** depends on how well humanity manages development, deployment, and oversight of AI powered robotics. This study recommends that stakeholders: federal government, industries and United Nations - collaborate to ensure safe, ethical, and effective integration and use of AI powered robotic engineering products in human societies.

**Keywords:** *Robotic Engineering, Artificial Intelligence, Public Perception, Ethics, AI Regulation.*

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### Introduction

Robotic engineering, a dynamic fusion of mechanical, electrical, and computer engineering, has rapidly evolved in the era of artificial intelligence (AI). Unlike when they were initially confined to repetitive industrial tasks, modern robots now demonstrate advanced capabilities in perception, decision-making, and learning. These have had transformative impacts on manufacturing industries, healthcare, agriculture, defense, and domestic services. These transformations, while promising, are accompanied by critical challenges. As AI-powered robotics become more autonomous and pervasive, concerns are mounting over mass unemployment, data privacy breaches, militarization, and the ethical alignment of machine behaviour. These tensions compel a fundamental inquiry: is the rise of robotic engineering a technological

blessing that enhances human potentials, or a timed bomb poised to threaten existential continuity of human race ethically, economically, and socially? This study critically examined this dual-edged trajectory. It explored the perceived benefits of AI integration in robotics across diverse sectors, investigated associated risks and ethical dilemmas, and evaluated public awareness and perception of AI-driven robotic technologies. In doing so, this study sought to establish if robotic engineering as practiced today will largely amount to a technological blessing, or tragedy to human race and consequent on findings make appropriate recommendations that identifies with strategic pathways for the safe, ethical, and effective deployment of AI powered robotic engineering.

## Literature Review

Recent scholarly work has highlighted both the transformative potential and inherent risks associated with AI-powered robotics. Between 2021 and 2025, a growing body of research has examined how robotics, fueled by machine learning, computer vision, and natural language processing, is reshaping domains such as healthcare, industry, logistics, and governance. The deployment of AI-driven robots in surgery, such as the da Vinci system, has revolutionized precision medicine (Wah, 2025), while intelligent systems in manufacturing have significantly improved efficiency and adaptability (Soori et al., 2024). However, concerns about the erosion of human expertise, decision-making accountability, and the deskilling of professions persist (Chamley, 2025).

The evolution of robotics has also been evaluated through key theoretical lenses. Human-Centered Design (HCD) emphasizes the alignment of robotics with human values, ensuring transparency and ethical interaction (Visciola, 2025). Similarly, Innovation Diffusion Theory (IDT) provides a framework to assess how robotics are adopted across societies, especially in the presence of cost barriers, regulatory inertia, and uneven technological readiness (Rogers, 2021). Ethical frameworks such as consequentialism and virtue ethics are increasingly applied to evaluate the societal and moral implications of autonomous systems (Sahakyan et al., 2021).

## Ethical and Societal Considerations

Ethical concerns are central to the discourse on AI robotics. The ambiguity around liability in the event of harm caused by robots presents a regulatory vacuum. Scholars have called for legal structures that clarify responsibility across stakeholders, including developers and users (Rahwan et al., 2021). Additionally, the autonomy of robots in warfare, surveillance, and healthcare provokes moral unease, particularly regarding consent and control (Porter, 2021; Eagan & Moseley, 2025). The pervasive use of personal data by AI systems raises further challenges around privacy and security, especially in autonomous vehicles and

surveillance robotics (Bendiab, 2023). There are also fears that increased automation may alienate human workers, leading to reduced agency and deeper social fragmentation (Shark, 2022).

## Economic Implications and Labor Disruption

The economic consequences of robotics are both promising and precarious. On one hand, AI robotics is predicted to generate new employment in sectors such as robotic system design and maintenance. On the other, the displacement of low-skilled labor remains a serious concern (Hu et al., 2024). The speed and scale of automation, if unmatched by proactive re-skilling and education policies, could exacerbate inequality, especially in developing countries with limited digital infrastructure.

## Regulation and Governance

Efforts to regulate AI and robotics are emerging unevenly across jurisdictions. The European Union's 2021 Artificial Intelligence Act is a landmark attempt to categorize AI systems based on risk, demanding transparency and accountability (PS, 2024). In contrast, regulatory responses in the United States remain fragmented. Scholars advocate for a global regulatory framework to reduce disparities, prevent regulatory arbitrage, and embed human-centric values in technological governance.

## Application Landscape

AI robotics are now deeply embedded in sectors including healthcare, logistics, military, agriculture, and education. Applications range from robotic arms and cobots in industrial settings, to autonomous vehicles and exploration drones in transportation and space research. Home automation, bioengineering, and entertainment robotics continue to gain traction, driven by improvements in sensor technology and machine learning algorithms. Robots such as Amazon's Astro, robotic vacuum cleaners, and surgical systems highlight the increasing integration of robots into daily life and professional practice.

## Methodology

This study adopted a descriptive survey design grounded in a quantitative research approach, aimed at exploring the perceptions, awareness levels of individuals with exposure to or experience in robotic engineering and possible impacts on human race. The study population comprised robotics professionals, students, and educators, selected for their relevance and potential insights into the subject matter. Purposive sampling technique was employed to enhance representativeness across different categories of stakeholders. A total of 401 respondents were drawn from the population of academics, industrialist, and robotic engineering experts. Data were collected using a structured questionnaire developed and disseminated via Google Forms. The

instrument consisted of opinion items designed to measure participants' perceptions regarding the risks, benefits, ethical considerations, and regulatory requirements associated with robotic engineering practice and product use. The quantitative data gathered were analyzed using descriptive statistics (means and standard deviations) to summarise the elicited responses while Pearson's correlation and linear regression were adopted in examining the relationships between awareness and key perception variables geared towards the primary objective of discovering if Robotic engineering will amount to an AI timed bomb or a budding blessing.

## Results and Discussion

**Table 1: Descriptive Analysis**

Variable	Category	Frequency (N)	Percent (%)	Cumulative Percent (%)
Age	18–25	24	6.0	6.0
	26–30	213	53.1	59.1
	31–35	92	22.9	82.0
	36–45	36	9.0	91.0
	46 & Above	36	9.0	100.0
Gender	Female	213	53.1	53.1
	Male	188	46.9	100.0
Occupation	Computer	261	65.1	65.1
	Science/Engineering Student			
	Engineer/Tech	116	28.9	94.0
	Teaching	16	4.0	98.0
	Healthcare Worker	4	1.0	99.0
Other	4	1.0	100.0	
Total Participants	—	401	100.0	—

The study involved 401 respondents, predominantly in the 26–30 years age group (53.1%), followed by those aged 31–35 (22.9%). The younger population (18–25) represented a small segment (6%), while older participants aged 26 years and above made up 94% collectively. In terms of gender distribution, females slightly outnumbered males, constituting 53.1% of the sample. The occupational breakdown reveals a strong academic and technical presence, with 65.1% being Computer Science or

Engineering students, and 28.9% categorized as Engineers or tech professionals. A small portion of respondents were involved in teaching (4%), healthcare (1%), or other fields (1%). This demographic distribution suggests that the study is highly representative of young, technically-oriented individuals, primarily from academic or engineering backgrounds, which is fitting for studies related to robotic engineering or technological awareness.

**Table 2: Participants' Robotic/AI System Awareness Level**

Aware (Yes / No)	Frequency	Percent	Valid Percent	Cumulative Percent
No	92	22.9	22.9	22.9
Valid Yes	309	77.1	77.1	100.0
Total	401	100.0	100.0	

From table 2, 77.1% of respondents reported awareness of robotic/AI systems. They generally agreed that robotics enhances productivity (M = 3.10) and working conditions (M = 3.24), but also acknowledged public unawareness (M = 3.15) and the need for ethical training

(M = 3.04). On the other hand, 22.9% of the respondents disagree of awareness of Robotic/AI System. This shows that most of the respondents were aware of the Robotic/AI System.

**Table 3: Correlation Analysis on What Informed Participants Awareness of Robotic / AI**

Relationship	r	Sig. (2-tailed)	Interpretation
AWARENESS and RISK	0.150	0.003	Weak positive correlation, statistically significant
AWARENESS and PERCEPTION	-0.067	0.182	Very weak negative correlation, not significant
RISK and PERCEPTION	-0.139	0.005	Weak negative correlation, statistically significant

From table 3, the correlation analysis reveals statistically significant but **weak associations** between the measured variables. **Risk perception** consistently shows a **positive link to awareness**, suggesting that individuals who perceive robotics as risky may pay more attention

or seek more information, thus increasing their awareness. Conversely, **general perception** has a weak or inconsistent relationship with awareness and risk, indicating it plays a limited role in shaping awareness.

**Table 4: Regression Analysis on What Informed Participants Awareness of Robotic / AI**

Predictor	B	SE B	$\beta$	t	p	Zero-order r
(Constant)	11.501	1.011	-	11.377	.000	-
SCORE_RISK	0.143	0.050	0.143	2.864	.004	.150
SCORE_PERCEPTION	-0.054	0.058	-0.047	-0.939	.348	-.067

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error	F	Sig. F	B (Unstd.)	Std. Error	Beta	t	Sig.
1	0.157	0.025	0.020	1.90787	5.010	0.007	11.501	1.011	-	11.377	.000
							0.143	0.050	0.143	2.864	.004
							-0.054	0.058	-0.047	-0.939	.348

**Note:** Dependent Variable = SCORE\_AWARE; Predictors = SCORE\_RISK, SCORE\_PERCEPTION.

The multiple regression analysis showed a statistically significant model,  $F(2, 398) = 5.010$ ,  $p = .007$ , with an  $R^2$  value of 0.025. This means that the combination of perceived risk and perceived benefits accounted for approximately 2.5% of the variance in awareness of robotic engineering. Among the predictors, perceived risk had a positive and significant effect on awareness ( $B = 0.143$ ,  $p = .004$ ), indicating that individuals who perceive higher risks associated with robotic engineering tend to have greater awareness of the field. In contrast, perceived benefits (SCORE\_PERCEPTION) did not significantly predict awareness ( $B = -0.054$ ,  $p = .348$ ), suggesting that viewing robotics positively does not necessarily correlate with increased awareness.

### Discussion of Findings

The findings of this study provide critical insights on Robotic engineering:- an AI timed bomb or a budding blessing. From the **descriptive analysis**, it is evident that the sample primarily consists of young, technically-inclined individuals, with over half of the respondents aged between 26–30 years and a majority (65.1%) being Computer Science or Engineering students. This demographic concentration suggests that the sample is well-suited for a study focused on robotics and AI technologies, as these individuals are likely to have greater exposure to and engagement with emerging technologies. Additionally, 77.1% of respondents indicated awareness of robotic or AI systems, which further confirms the relevance of the topic among this group. Despite the high level of reported awareness, responses also reflected an understanding that the general public may still lack full awareness, as shown in the agreement that “the public is largely unaware” ( $M = 3.15$ ) and that there is a need for “ethical training” in robotics ( $M = 3.04$ ). This suggests a perceived gap between those with technical exposure and the broader society.

The **correlation analysis** supports this perspective. A weak but statistically significant positive correlation was found between **awareness and perceived risk** ( $r$

$= 0.150$ ,  $p = .003$ ), implying that individuals who are more aware of robotic systems also tend to perceive them as risky. This may be because greater knowledge of robotics includes understanding of potential dangers such as job displacement, ethical dilemmas, or privacy concerns. On the other hand, **perceived benefits** showed a very weak and non-significant negative correlation with awareness ( $r = -0.067$ ,  $p = .182$ ), suggesting that positive views on robotics do not strongly influence awareness levels.

The **regression analysis** further supports these relationships. The overall model was statistically significant,  $F(2, 398) = 5.010$ ,  $p = .007$ , although the effect size was small ( $R^2 = 0.025$ ), indicating that only 2.5% of the variance in awareness can be explained by the combined influence of perceived risk and benefits. Importantly, only perceived risk had a statistically significant effect on awareness ( $B = 0.143$ ,  $p = .004$ ), while perceived benefits did not ( $B = -0.054$ ,  $p = .348$ ). These findings suggest that risk-related concerns are a more powerful motivator for awareness than positive attitudes. This could be because risk invokes a stronger emotional or cognitive response, prompting individuals to seek information or engage more deeply with the subject.

In summary, this study shows that while robotic engineering benefits are substantial such as improved efficiency, precision, safety, and innovation as well as the creation of new high-skilled employment opportunities, these advances however present significant risks and dilemmas also. The increasing autonomy of robots raises concerns about mass unemployment, widening social inequality, data privacy breaches, weaponization, and ethical alignment of machine behaviour.

### Conclusion and Recommendations

#### Conclusion

Robotics engineering, a blend of electrical, mechanical and computer engineering has developed extremely rapidly in the wake of artificial intelligence. Contrary to their first use in boring industrial operations, robots today possess skills in learning, decision-making,

and perception, transforming manufacturing, healthcare, agriculture, defense, and home services. Though such innovations promise a lot of benefits, they are also responsible for causing gravely consequential problems. Among them are mass unemployment because of automation, eroding information privacy informed by information privacy invasions; militarization of autonomous systems and skepticism about the alignment of machine actions on moral lines.

While existing literature has not failed to reveal the increasing efficiency and precision of robotic systems in many fields such as in surgery through the da-Vinci system, they also showcase disturbing issues like responsibility, human skill loss, and social injustice. Terms such as Human-Centered Design and Innovation Diffusion refer to the ways in which robotics can be aligned with human values and adoption patterns. This is what informs scholars demand for open regulation on AI powered robotics.

Consequently, whether robotic engineering will either be an AI blessing or a time bomb, depends strongly on how stakeholders manage related risks and utilise ethical paradigms in connection with Robotics and related AI products.

### Recommendations

To regional organisations like AU and UNO, national governments, industries, and stakeholders in adoption and implementation of Artificial Intelligence in robotics in Nigeria and beyond, the researcher recommends integration of AI and ethics education into academic and professional curricula, standardisation of ethical training for robot designers and developers and promotion of collaborative governance across sectors.

And to fellow researchers, for future research, expansion into underrepresented and low-resource environments is recommended. In addition, the researcher also recommend conducting longitudinal studies to evaluate evolving public perceptions and impacts.

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## EFFECTS OF COMPUTER-BASED INSTRUCTIONAL STRATEGY ON STUDENTS' LEARNING OUTCOMES IN BIOLOGY IN SENIOR SECONDARY SCHOOLS IN EKITI STATE

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### Abstract

*This study investigated the effects of Computer-Based Instructional Strategy on students' learning outcomes in Biology in senior secondary schools in Ekiti State. The study examined the effects of CBIS on students' performance, attitude and retention in comparison with the conventional teaching method. The study adopted quasi-experimental research design. The population comprised 12,690 (SSII) students from 206 public secondary schools, with a sample of 159 SS II students selected using multistage sampling procedure. Data were collected using Biology Performance Test (BPT) and Students Attitudinal Questionnaire in Biology (SAQB). The instruments were validated by experts in Tests, Measurement, and Evaluation as well as Biology Science Education, and were found to be reliable. The reliability coefficient of the instruments was 0.87, while the internal consistency of the SAQB was 0.88. Ten weeks were used altogether for the whole study. Data collected were analyzed using mean, standard deviation, bar chart and t-test at 0.05 level of significance. Findings revealed that students exposed to CBIS outperformed those taught using the conventional method. It is recommended that teachers should be trained on the use of CBIS in order to enhance students' learning outcome.*

**Keywords:** Computer-Based Instruction, Retention Ability, Performance, Attitude, Location

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### Introduction

The growth and progress of a nation depend majorly on advancements in education and technology. For a long time, it seems technology have not been fully adopted into Nigerian secondary schools to enhance their teaching and learning practices. Olaniyi and Ajayi (2020) observed that most secondary schools still lack adequate supply of computer gadgets and regular supply of electricity to operate the available few where they exist. Therefore, there is need for adequate supply of gadgets and regular supply of electricity which could increase the quality of education.

Education is an empowering process that involves the inculcation of valuable knowledge and skills to individuals, enabling them to become self-sufficient members of the society. It embodies both the act of teaching and learning, with the aim of developing positive qualities and

inner potential. Through education, individuals gain essential knowledge, skills, understanding, attitudes, interests, and critical thinking abilities that are crucial for survival and contributing to the progress of the society. A person who is educated has the ability to think positively and make valuable decisions in life. In order for education to be relevant in a person's life, retention ability is crucial in order to put to use what had been learnt. According to Olaniyi and Ajayi (2020), student's interest and retention could be aroused and retained through the use of multimedia instruction approach.

The major national goals of Nigeria National Policy on Education according to the National Policy on Education (NPE, 2014), are the building of a free and democratic society, a just and egalitarian society, a united, strong and self-reliant nation; a good and dynamic economy, a

land full of bright opportunities for all citizens. For personal empowerment and societal advancement, there is need for functional education for the promotion of a progressive and united Nigeria. Therefore, school programmes need to be relevant, practical and comprehensive hence, education should be based on the development of individual into a sound and effective citizen. Relevant and appropriate skills should be acquired which will enhance the development of mental, physical and social abilities through education, which is the process of facilitating learning or the acquisition of knowledge, skills, values, beliefs, and habit which brings positive changes in human life and behaviour.

Science education as part of education focuses on the inculcation of scientific knowledge in the individuals and the acquisition of desirable scientific knowledge. It enhances the use of observation and experimentation to describe and explain a phenomenon. The aim of science education also includes increasing the benefits science could offer and using such benefits to strengthen technology. Science education also aims at providing people with the knowledge needed for societal development, to ensure the means of physical survival, to develop a cohort of trained scientists necessary for national development and to promote technological advancement. These goals are further enhanced by the integration of Information and Communication Technology (ICT) in the school curriculum, which seems to play an important role in promoting technological growth.

Biology, as a branch of science, has been defined as one of the natural disciplines that focus on living things. Biology is concerned with the study of life, no wonder it is usually referred to as the study of life. Biology also investigates the structures, functions, growth, origin, evolution, distribution, inter-relationships, and adaptations of living species, among other things. Biology frequently overlaps with other sciences such as, Biochemistry, which combines Biology and Chemistry, and Astrobiology, which combines Biology and Astronomy (Omotayo & Osuala 2023).

Biology is inherently interdisciplinary, forging connections with diverse scientific domains. Modern biological research frequently integrates principles from Chemistry, Physics, Mathematics, and Computer Science. For instance, computational Biology utilizes mathematical models and algorithms to analyze biological data, fostering a deeper understanding of complex biological phenomena (Aluru, 2021). The field

of Biology is characterized by specialized branches that cater for specific areas of study. Examples include; genetics, a pivotal branch, which explores heredity and variation, unraveling the molecular mechanisms underlying inheritance (Pierce, 2021); microbiology which investigates microorganisms, shedding light on their roles in health, disease, and environmental processes (Tortora, Funke & Case, 2019).

Biology, as a dynamic scientific discipline, offers the foundational tools to unravel life's complexities. Its interdisciplinary breadth, diverse specialized fields, and practical applications underscore its pivotal role in advancing scientific knowledge and contributing to societal development. According to Ahmad, Abubakar, and Yau (2018), biology education significantly contributes to technological advancement and national development.

Biology education has remained one of the crucial subjects at secondary school levels in Nigeria education. It occupies a very important position in medical science and related disciplines and has therefore been made one of the compulsory subjects of instruction. This is because it provides learners with a broad range of knowledge that is relevant to various aspects of life and human development. Biology is also a pre-requisite to many fields of learning such as Pharmacy, Agricultural Science and Nursing among others. It contributes immensely to the scientific development of nations, it is a key part of life because it is needed by everyone for a successful living, it is a bedrock upon which scientific and technological advancement rest. As Akinwumi, Olojo, Falemu, and Olu-Ajayi (2024) emphasized, biology plays a pivotal role in nation-building, and integrating ICT into its instruction is essential for unlocking that role. Consequently, Biology occupies a unique position in the school curriculum.

Having seen the importance of Biology, it seems most students still regard and learn Biology in abstraction, no wonder their performance in the subject is unimpressive (Nuru, Adamu and Anthony, 2024). Students' low performance in science, particularly Biology, has been a major source of concern for all, particularly those in the main stream of science. Despite the significant role Biology occupies in our educational system, it has been observed that students perform poorly in the subject both in internal and external examinations. Over the years, examination bodies specifically WAEC chief examiners reports (2019, 2020, 2021,

2022, and 2023), have been reporting the poor performance of students in biology. It seems some students still consider Biology as voluminous and difficult to understand which has resulted in poor learning outcomes among students. Students seem to have difficulties in learning and understanding the basic biological concepts.

Table 1 shows the analysis of academic performance of secondary school students in Biology in West African Senior Secondary School Certificate Examination (WASSCE) in Ekiti State.

**Table 1: Students' Performance in Biology in WASSCE between 2019 and 2023**

Year of Exam	Total No. of Candidates	A1-B3	%	C4-C6	%	D7-E8	%	F9	%	% Pass	% Fail
2019	6691	744	11	3200	48	1657	25	1060	16	59	41
2020	6022	1622	27	3108	52	668	11	624	10	79	21
2021	5641	1120	20	3333	59	761	13	427	8	79	21
2022	2499	491	20	1509	60	185	7	314	13	80	20
2023	5563	824	15	3098	56	1069	19	572	10	71	29

Source: Ministry of Education, Planning, Research and Statistics Department, Ekiti State (2024).

Table 1 shows that while students' performance in Biology may initially seem promising, a more detailed analysis reveals an inconsistent pattern over the years. For example, in 2019, 59% of students attained grades between A1 and C6. This figure rose to 79% in both 2020 and 2021, and further increased to 80% in 2022. However, a decline was observed in 2023, with only 71% of students achieving grades within the A1–C6 range. Only a small proportion of students attained excellent grades (A1–B3), with percentages ranging from just 11% to 27%, while a relatively higher percentage consistently achieved credit-level passes (C4–C6). The data also shows that a notable number of students fall within the D7–F9 range. These lower grades could be due to a lack of adequate understanding or mastery of the subject, which may be attributed to ineffective teaching methods adopted by some Biology teachers. Unfortunately, students who fall into this category may be denied admission into higher institutions, as their grades do not meet the required standards. Furthermore, the inconsistency in failure rates across the five-year period emphasizes the urgent need for improved instructional strategies, continuous teacher development, and a stronger student support system. Without addressing these critical issues,

students may continue to underperform, and many could be denied access to higher education due to poor academic outcomes in Biology.

Based on the analysis shown above, there appears to be a need for improvement in the subject. There are various possible ways and approaches by which the problems militating against the teaching and learning of Biology in senior secondary schools could be solved. Amongst these are the use of Computer-Based instructional strategy, provision of relevant instructional teaching aids, use of appropriate and effective teaching method, provision of well-equipped laboratories, provision of suitable incentives for Biology teachers, and so on. Students seem not to have the right attitude towards the subject but it is believed that if the learning environment is conducive, motivational and attractive with all relevant instructional strategies, this might improve their performance in the subject and their participation in the class work might be encouraging and positive. The most important thing for a teacher is to get used to the teaching method that would help students achieve their learning objectives. If the talk and chalk mode of teaching seems insufficient in educating an individual, then one of the most effective things to do is to take advantage of instructional technologies, especially



the Computer-Based Instructional strategy (CBIS). Computer literacy is very much needed for teachers as well as learners. Abidoeye (2015) opined that the information technology revolution has led to rapid development and expansion across a wide range of areas in the modern world. Educational institutions may benefit from recognizing the potential advantages of recent changes to enhance the teaching and learning environment and respond to the growing demand for education and training. Educators globally appear to be continually exploring strategies to enhance student engagement and improve learning outcomes, making the search for more effective instructional methods an ongoing area of interest. Integrating computers as an instructional strategy could help foster a more interactive environment between teachers and students. Computers have the potential to support self-directed learning and may offer engaging opportunities for learners, including those with learning difficulties. While teachers traditionally play a central role in instruction, Computer-Based Learning environments might enhance communication and collaboration between teachers and learners through the use of technology.

Computer-Based Instructional strategy (CBIS) is a modern teaching-learning strategy in which the topics to be taught are carefully planned and written in a computer in order to facilitate communication between the teacher and the learners. It is an interactive instructional technique whereby a computer is used to present the instructional materials and monitor the learning that takes place. Therefore, Computer-Based instructional strategy will provide an interesting and appropriate environment for teaching and learning. It is assumed that Computer-Based instructional strategy may support students in developing their practical problem-solving skills and enhance learning. While traditional face-to-face learning environments have existed for centuries, Computer-Based Learning has gradually expanded with the advent of new technologies that have opened up greater possibilities for communication and interaction.

Computer-Based instructional strategy is considered to play a vital role in education by potentially enhancing teaching and learning and helping students to acquire relevant skills and competencies. Computer-Based learning offers a diverse set of tools that can be used to support a variety of learning experiences. One such tool

is PowerPoint aided instruction, which allows for the organized and visual presentation of content. PowerPoint, as a slide show tool, would enable students and teachers to incorporate text, video, audio, and images into classroom presentations, thereby potentially facilitating enhanced learners' engagement. In classroom teaching, the interactive features of PowerPoint, such as animations, transitions, embedded quizzes, and multimedia content, can contribute to making lessons more accessible, dynamic, and engaging. These features would allow teachers to present complex concepts in a simplified and visually appealing manner, while also encouraging student participation. Furthermore, the use of PowerPoint in Computer-Based Instructional Strategy (CBIS) may support inquiry-based learning, where students are guided to explore concepts, ask questions, and investigate topics, ultimately improving their understanding and critical thinking skills. This seems to significantly boost students' motivation and engagement, enhancing a more positive attitude toward Biology.

Students might show more positive attitude after being exposed to self-learning strategy such as Computer-Based Instructional strategy. Attitude is likely to affect people in everything they do, hence, attitude may determine students' behaviour. It has been observed that a number of factors might affect students' attitude which may include the attitude of teachers, content difficulties, career interest, absence of practical demonstrations and instructional techniques among others.

According to Akinwumi, Falemu and Olu-Ajayi (2023), it is generally believed that students' attitude towards a subject determines their success in that subject. In other words, a favourable attitude results in good achievement in a subject. A student's successful experience may make him to develop a positive attitude towards learning a subject while his failure may make him exhibit a poor attitude towards the learning of the subject. However, a study by Obeka (2018) shows that different teaching methods can influence students' attitudes, with some strategies being more effective than others in fostering positive attitudes towards a subject. The attitude of students towards Biology could be either positive or negative depending on age, previous experience, and availability of textbooks, classroom activities, Laboratory activities, academic performance and general philosophy

of the students (Achor, Imoko & Uloko, 2017; Ojo & Ogbeba, 2019).

Also, the influence of urban-rural settings may also extend to Biology, as is often the case with other science subjects. This factor could potentially shape students' academic performance in science, including Biology. Students in rural areas are often perceived to face economic challenges and traditional societal norms, with limited access to basic social amenities. In such settings, the standard of living might influence both teaching and learning experiences. Urban schools, by contrast, tend to have relatively better infrastructure, access to electricity, a higher number of qualified teachers, and improved learning facilities. These advantages may make urban schools more attractive to both academically inclined students and committed educators. Based on the researcher's observations, students in urban areas appear to perform better academically compared to their rural counterparts, though this trend may be influenced by several socio-economic and institutional factors. Enriched environment could result to better understanding of the subject taught and hence enhance better performance of student which could bring about different positive responses and behaviours from the learners.

### **Purpose of the Study**

The main purpose of this study is to investigate the effects of Computer-Based Instructional Strategy on students' learning outcomes in Biology in senior secondary schools. The study will also:

- i. determine the effects of Computer-Based Instructional strategy on students' attitude towards Biology.
- ii. determine the performance of senior secondary school student in Biology with the use of Computer-Based instructional strategy
- iii. find out the effects of Computer-Based Instructional strategy on students' retention in Biology.
- iv. examine the influence of school location on the performance of students in Biology.

### **Research Questions**

The following research questions were raised to guide the study:

1. To what extent do students' exposure to Computer-Based Instructional strategy influence their performance in Biology?

2. To what extent do students' exposure to Computer-Based Instructional strategy influence their attitude towards Biology?

### **Research Hypotheses**

The following null research hypotheses were formulated and will be analyzed in this study:

1. There is no significant difference in the pre-test performance of students in the experimental and control groups.
2. There is no significant difference in the attitudinal scores of students in the experimental and control groups before the treatment.
3. There is no significant difference in the post-test performance of students in the experimental and control groups.
4. There is no significant difference in the attitudinal scores of students in the experimental and control groups after treatment.
5. There is no significant difference in the retention ability of students exposed to Computer-Based Instructional Strategy.
6. There is no significant difference in the performance of students in rural and urban schools after being exposed to Computer-Based Instructional strategy.

### **Methodology**

The study adopted quasi-experimental research design. The population for the study consisted of all the 12,690 Senior Secondary School two (SSII) students offering Biology in all the 206 public secondary schools in the sixteen Local Government Areas of Ekiti State. The sample for the study consisted of 159 SSS II students offering Biology selected using multistage sampling procedure. In the first stage, simple random sampling technique was used to select one of the three senatorial districts in the state. In the second stage, simple random sampling technique was used to select two Local Government Areas from the selected senatorial district. The third stage involved the selection of four schools from the selected Local Government Areas using stratified random sampling technique based on location, urban and rural categories. From the urban stratum, two schools with functional projectors were purposively selected because they met the requirements for implementing the Computer-Based Instructional Strategy. From the rural stratum, two schools without projectors were also purposively selected to serve as schools using the conventional method. The four schools that were selected were randomly assigned to experimental and



control groups respectively. In the final stage, students in their intact classes from each of the four schools selected served as the sample for the study.

Two research instruments tagged “Biology Performance Test (BPT)” and “Student’s Attitudinal Questionnaire in Biology (SAQB)” were used for data collection, both were constructed by the researcher. The Biology Performance Test (BPT) consisted of two sections: A and B. Section A consisted of respondents’ biodata while section B contained 20 multiple choice items with four options. Correct option for each item of the instrument was scored 1, while each incorrect response was scored 0. The BPT was used as pre-test and post-test for both the experimental and control groups respectively. Student’s Attitudinal Questionnaire in Biology (SAQB) also consisted of two sections: A and B. Section A consisted of respondents’ biodata while section B contained 20-item statements which were used to gather information on disposition of the students towards the learning of Biology. It was structured on 4- point Likert rating scale, ranging from Strongly Agree (SA)= 4points, Agree (A) = 3points, Disagree (D) = 2points and Strongly Disagree (SD)= 1point.

The instruments were validated by an expert in Test and Measurement, two secondary school Biology teachers, and finally the researcher’s supervisor to ascertain that the instruments measured what they were supposed to measure. The reliability of the instruments was determined using the test-retest method. The scores obtained from the BPT were analyzed using Pearson’s Product Moment Correlation statistics which yielded a reliability coefficient of 0.87, indicating a high level of reliability while the internal consistency of the SAQB was determined using Cronbach’s Alpha statistics, which yielded a reliability coefficient of 0.88 at 0.05 level of significance.

The research procedure occurred in three stages, namely: the pre-treatment stage (one week), the treatment stage (six weeks) and the post-treatment stage (one week). During the pre-treatment stage, the researcher visited the schools to obtain permission and approval from the principals to use their schools, teachers and

students for the research before the commencement of the experiment. After this, the instruments BPT and SAQB were administered as pre-test to ensure that the groups were homogenous before the treatment began. During the treatment stage, which lasted for six weeks, the students in the experimental group were exposed to the selected concepts in Biology using PowerPoint and Video aided Instruction while the students in the control group were taught the same concepts using the regular chalk-talk teaching method. The treatment was systematically administered by the researcher with the help of research assistants. At the beginning of the week that followed the treatment stage period, Biology Performance Test (BPT) was administered, as post-test to measure the performance of the sampled students in each of the experimental and control groups in the schools chosen. The Student’s Attitudinal Questionnaire in Biology (SAQB) was also administered to determine the students’ attitude towards Biology after treatment. This stage lasted for a period of one week. After two weeks, the items of the Biology Performance Test (BPT) that was used for both pre-test and post-test was re-administered on the students in both experimental and control groups respectively. The scores and responses to the instruments were collated as the retention scores. Data collected were analyzed using descriptive and inferential statistics. Descriptive statistics such as mean, standard deviation and bar chart were used to answer the research questions raised while all hypotheses generated were tested at 0.05 level of significance using t-test.

## Results

**Research Question 1:** To what extent do students’ exposure to Computer-Based Instructional strategy influence their performance in Biology?

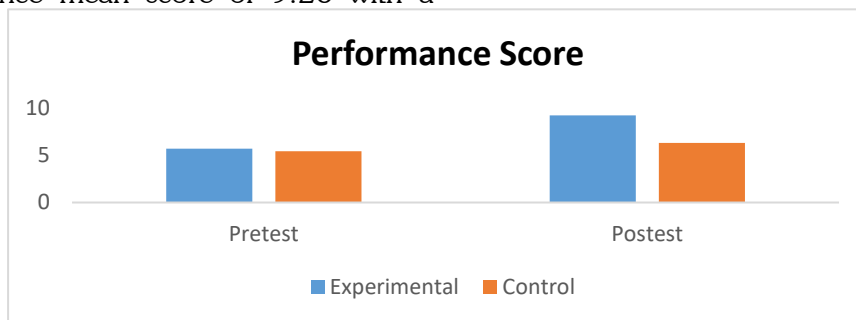
In answering this research question, mean and standard deviation of the scores of students exposed to Computer-Based Instructional Strategy and conventional method of teaching Biology before and after treatment were computed and compared. The result is shown in Table 2 and Figure i.

**Table 2:** Performance Mean Scores and Standard Deviation of Students before and after the treatment

Group	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Experimental	88	5.72	1.73	9.26	2.91	3.54

Control	71	5.45	1.96	6.31	2.67	0.86
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As shown in Table 2 above, prior to the treatment, the experimental group recorded a pretest mean score of 5.72 with a standard deviation of 1.73, while the control group had a slightly lower mean score of 5.45 and a standard deviation of 1.96. Based on the relatively close mean scores, it appears that the groups are homogenous prior to the treatment. After exposure to Computer-Based Instructional Strategy, the experimental group achieved a higher performance mean score of 9.26 with a standard deviation of 2.91, while the control group had performance mean score of 6.31 with a standard deviation of 2.67. This suggests that Computer-Based Instructional Strategy appears to enhance students' performance and understanding of Biology more than the conventional method. Students' performance in Biology before and after treatment is presented in Figure i.



**Figure i:** Bar Chart Representation of Performance Mean Scores of Students in Experimental and Control groups respectively.

**Question 2:** To what extent do students' exposure to Computer-Based Instructional strategy influence their attitude towards Biology?

experimental and control groups were computed and compared. The result is as shown in Table 3 and Figure ii.

In order to answer this question, the pretest and posttest mean attitude scores of students in the

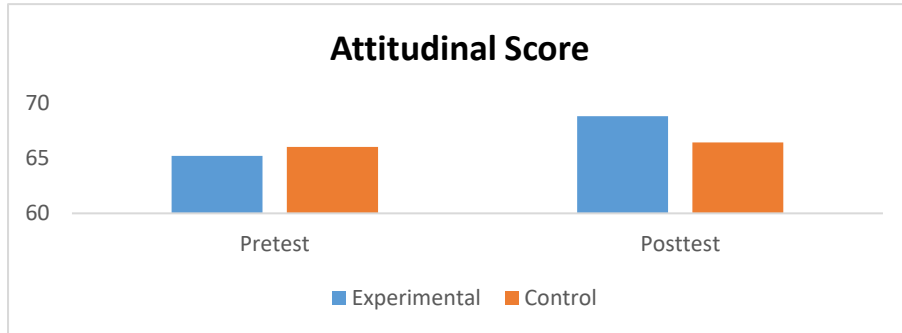
**Table 3:** Attitudinal Mean Scores and Standard Deviation of Students in Experimental and Control groups respectively

Group	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Experimental	88	65.20	9.38	68.81	7.03	3.61
Control	71	66.03	7.40	66.44	7.53	0.41

Table 3 above shows that prior to treatment, the students in the experimental group had a pre-attitudinal mean score of 65.20 with standard deviation of 9.38, while students in the control group recorded pretest mean attitude score of 66.03 and standard deviation of 7.40. On exposure to Computer-Based Instructional Strategy, students in the experimental group had a higher post attitudinal mean score of 68.81,

while the students in the control group had post attitudinal mean score of 66.44. This shows that the use of CBIS appears to be more effective than the conventional method in fostering a more favourable and positive attitude towards the study of Biology. Students' attitude towards Biology before and after treatment is represented in Figure ii.

**Figure ii:** Bar Chart Representation of Attitudinal Mean Scores of Students in Experimental and Control Groups respectively.



**Testing of Hypotheses**

**Hypothesis 1:** There is no significant difference in the pre-test performance of students in the experimental and control groups.

In order to test Hypothesis 1, the mean scores of students in experimental group and control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 4.

**Table 4:** t-test summary of Pre-test Scores of Students in Experimental and Control Groups

Group	N	Mean	SD	df	t	p
Experimental	88	5.72	1.73	157	0.91	0.37
Control	71	5.45	1.96			

**p<0.05 (Not Significant)**

From Table 4, p-value is greater than 0.05, hence, the hypothesis is not rejected. This indicates that there was no significant difference in the pretest performance mean scores of students in the experimental and control groups. Therefore, the hypothesis that says there is no

significant difference in the pre-test performance of students in the experimental and control groups respectively was not rejected. This shows that the two groups were homogeneous at the commencement of the experiment.

**Hypothesis 2:** There is no significant difference in the attitudinal scores of students in the experimental and control groups before the treatment.

To test Hypothesis 2, pre-attitudinal mean scores of students in experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 5.

**Table 5:** t-test summary of the Pre-attitudinal Scores of Students in the Experimental and Control Groups

Group	N	Mean	SD	df	t	p
Experimental	88	65.20	9.38	157	-0.62	0.54
Control	71	66.03	7.40			

**p<0.05 (Not Significant)**

The result in Table 5 above shows that since the p-value is greater than 0.05, the hypothesis is therefore not rejected. This indicates that there was no significant difference in the pre-

attitudinal mean scores of students in the experimental and control groups respectively. This shows that the two groups were statistically

equivalent in terms of their attitude towards Biology at the commencement of the study.

**Hypothesis 3:** There is no significant difference in the post-test performance of students in the experimental and control groups respectively.

Table 6: t-test summary of Post-test Mean Scores of Students in Experimental and Control Groups respectively

Group	N	Mean	SD	df	t	p
Experimental	88	9.26	2.91	157	6.94	.000
Control	71	6.23	2.51			

#### **P<0.05 (Significant result)**

Result from Table 6 above shows that the p-value is less than 0.05, hence, the hypothesis is rejected. This indicates that there was a statistically significant difference in the post-test mean scores of students in the experimental and control groups. Notably, students in the experimental group achieved significantly higher post-test performance scores in Biology than their counterparts in the control group. This outcome suggests that the improvement in students' performance can be attributed to the instructional treatment, as the experimental group recorded superior post-test outcomes despite their relatively lower initial pre-test mean

To test Hypothesis 3, the post-test mean scores of students in experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 6.

score. This result further shows that the treatment is effective in enhancing students' performance in Biology.

**Hypothesis 4:** There is no significant difference in the attitudinal scores of students in the experimental and control groups after treatment.

To test Hypothesis 4, the post-test attitudinal mean scores of students in experimental group and those in the control group were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 7.

Table 7: t-test summary of the Post-attitudinal Mean Scores of Students in the Experimental and Control Groups respectively

Group	N	Mean	SD	df	t	p
Experimental	88	68.81	7.03	157	2.05	0.04
Control	71	66.44	7.53			

#### **p>0.05 (Significant result)**

From Table 7 above, the p-value 0.04 is less than 0.05, thus, the hypothesis is rejected. This implies that there was significant difference in the attitude of students exposed to Computer-Based Instructional Strategy and those exposed to conventional method in Biology. Although the control group demonstrated a more positive attitude towards Biology at the pre-test stage, the post-test results showed an impressive improvement in the attitude of students in the experimental group following exposure to the Computer-Based Instructional Strategy, while the attitude of students in the control group only

improved slightly. This improvement suggests that the treatment had a positive influence on students' attitude towards Biology by making learning more engaging and interesting.

**Hypothesis 5:** There is no significant difference in the retention ability of students exposed to Computer-Based Instructional Strategy.

To test Hypothesis 5, the retention mean scores of students in experimental group were computed for statistical significance using t-test at 0.05 level. The result is presented in Table 8.

**Table 8:** t-test summary of the Retention Mean Scores of the Students in the Experimental and Control Groups

<i>Group</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>
Experimental	88	8.90	3.04	157	6.32	0.00
Control	71	6.00	2.66			

**p>0.05 (Significant result)**

The result in Table 8 shows that since the P-value 0.00 is less than 0.05, the hypothesis is rejected. This indicated that there was significant difference between the retention mean score of students exposed to Computer-Based Instructional Strategy and those exposed to conventional method in Biology. This result showed that the treatment had a significant effect on the retention of students in the experimental group compared to those in the control group.

**Hypothesis 6:** There is no significant difference in the performance of students in rural and urban schools after being exposed to Computer-Based Instructional strategy.

To test Hypothesis 6, the post-test mean scores of students taught with Computer-Based Instructional Strategy in urban and rural schools were computed and compared for statistical significance using t-test at 0.05 level. The result is presented in Table 9.

**Table 9:** t-test summary of the Post-test Mean Scores of the Students in the Experimental Groups based on Location

<i>Group</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>
Urban	65	8.26	2.87	86	-5.49	0.000
Rural	23	11.09	1.78			

**p<0.05 (Significant result)**

Results from Table 9 indicated that the p-value was less than the 0.05 level of significance; therefore, the null hypothesis was rejected. This finding revealed a statistically significant difference in the academic performance of students in rural and urban locations after exposure to the Computer-Based Instructional Strategy (CBIS). Contrary to general expectations, students in the experimental group from the rural area interestingly performed better than their counterparts in the urban area, despite both groups being exposed to the same instructional treatment. This outcome may be attributed to differences in students' prior exposure to computer-based facilities. Many rural schools lack adequate modern instructional technologies, and where such facilities exist, they are often underutilized. Consequently, students in the rural experimental group may have shown greater interest, enthusiasm, and receptiveness to the Computer-Based Instructional Strategy, which positively influenced their learning outcomes. In contrast, students in urban schools are more likely to be familiar with computer facilities, making the use of CBIS less novel and

less stimulating during the study. The findings of this study therefore indicate that school location significantly influenced students' academic performance following exposure to the Computer-Based Instructional Strategy, with rural students benefiting more from the intervention than their urban counterparts.

**Discussion**

Findings from this study revealed that both the experimental and control groups recorded low pre-test mean scores. This may be attributed to the continued reliance on conventional teaching methods commonly used in the teaching of science subjects, including Biology, which have been reported to be largely teacher-centred and less effective in promoting deep understanding of scientific concepts. This observation is consistent with the findings of Adebayo and Olatoye (2018), who noted that traditional instructional methods often fail to adequately engage students or address difficulties associated with abstract science concepts. The similarity in the pre-test mean scores of the two groups



further indicates that the students were comparable in terms of their baseline knowledge prior to the experimental treatment. This implies that any difference observed in performance at the post-test stage can be attributed to the instructional strategy employed rather than chance. This position aligns with the views of Adeyemi (2019) and Ogunleye and Babajide (2020), who emphasized the importance of establishing group equivalence in experimental studies to ensure the validity of treatment effects.

The experimental group recorded a higher post-test mean score than the control group. This finding suggests that CBIS is more effective in improving students' academic performance and understanding of Biology than the conventional teaching method. Similar findings have been reported by Ajayi, Lawal, and Adeyanju (2021) that computer-based and multimedia instructional strategies significantly enhanced students' achievement in science subjects. The improved performance of the experimental group may be attributed to the visual, interactive, and learner-centred nature of CBIS, which enables students to better comprehend abstract biological concepts. According to Oladipo and Akinyemi (2022), instructional strategies that incorporate visual representations and interactive elements help learners to actively construct knowledge, thereby leading to improved understanding and retention. This finding also supports the submission of Oyelekan, Olorundare, and Akande (2023) that technology-driven instructional approaches promote deeper learning and sustained interest in Biology among secondary school students. The findings of this study support the assertion that teaching approach plays a crucial role in shaping students' learning outcomes in Biology, aligning with the view of Yap (2016) that instructional strategies significantly influence students' attitudes and academic achievement in Biology.

One major observation from this study is the positive effect of CBIS on students' academic performance. The findings show that students exposed to CBIS performed better than their counterparts in the control group, suggesting that this instructional approach is more effective in facilitating students' understanding and mastery of Biology concepts than the traditional teaching method. This aligns with the findings of Ndagie, Oloruntimilehin, Awoniyi, and Adebola (2020), who reported that CBIS significantly enhances students' mastery of scientific concepts by challenging misconceptions

and reinforcing correct frameworks through interactive simulations. The researcher attributes the observed improvement in students' performance to the interactive and learner-centred nature of CBIS. The integration of animations, simulations, and multimedia presentations likely increased student engagement and enabled them to visualize abstract biological processes more clearly. This supports the submission of Azih, Anugwo, and Agbogo (2022), who noted that CBIS provides learners with structured, technology-driven instruction designed not only to transfer knowledge but also to foster interaction, motivation, and sustained engagement in the learning process.

The study further demonstrated that CBIS appears to be more effective than the conventional method in fostering a more positive attitude towards Biology. Although the control group initially demonstrated a more positive attitude towards Biology at the pre-test stage, the post-test results showed an improvement in the attitude of students in the experimental group following exposure to the Computer-Based Instructional Strategy, while just a slight improvement was observed among students in the control group. This pattern indicates that the treatment had a positive influence on students' attitude towards Biology, as reflected in increased interest and engagement in the learning process. This is in consonance with the submission of Jegede (2016) that teaching is made effective when the method used brings about a desirable change in the behaviour of the learners. The researcher believes that the use of Computer-Based instructional strategy will enable the students to understand Biology concepts effectively leading to a positive shift in their attitude towards Biology compared to the conventional methods. This finding is in consonance with the assertion of Ajayi (2016) that a positive attitude towards science significantly correlates with students' performance in the field.

Furthermore, the findings of the study indicate that students taught using the Computer-Based Instructional Strategy (CBIS) were able to recall learned biological concepts more effectively over time compared to those taught using the conventional method. This finding showed that there was a significant difference in the retention mean scores of the experimental and control groups, with the experimental group demonstrating higher retention ability. This suggests that the use of CBIS not only supports immediate learning but also facilitates long-term



memory and retention. This observation aligns with the findings of Ajayi (2025) that the incorporation of digital tools in education enhances students' retention of learned concepts. The use of platforms such as Google Classroom in teaching not only improves academic performance but also strengthens retention, as the interactive nature of such platforms allows for repeated exposure to content and sustained engagement. Similarly, Nwafor, Ekoyo, and Ezenwobodo (2023) observed that students who displayed interest and enthusiasm in science, particularly during practical activities, demonstrated greater conceptual understanding and improved retention of knowledge.

The results of this study showed a noticeable difference in the post-test mean scores of students exposed to the Computer-Based Instructional Strategy (CBIS) in rural and urban schools, and this difference was found to be statistically significant. Interestingly, and contrary to general expectations, students in the experimental group from the rural school performed better than their counterparts in the urban school. This finding appears surprising, as it contrasts with the commonly held view that urban schools tend to have an advantage over rural schools due to better facilities and availability of qualified teachers. Adesoji and Olatunbosun (2018) had earlier observed that school location could influence students' academic performance, noting that rural schools often face challenges such as inadequate facilities and teacher shortages, which may adversely affect students' motivation and academic achievement. While earlier studies, such as Ajayi and Ogunyemi (2015) reported no significant difference in the academic achievement of students from rural and urban areas, the findings of the present study suggest that exposure to CBIS can help reduce the challenges often associated with school location. In this study, students in the rural experimental group performed better than their counterparts in the urban group, indicating that effective use of innovative instructional strategies such as CBIS can enhance learning outcomes in rural schools. This result therefore suggests that school location alone may not be a major factor influencing students' academic performance when

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appropriate and technology-based instructional approaches are employed. The effective use of CBIS can help bridge, and even reverse, the perceived performance gap between rural and urban students.

To this end, the researcher also observed that adopting Computer-Based Instructional Strategy into the teaching and learning of Biology will significantly improve students' performance in Biology as well as enhance their active participation and interactions in the Biology classroom, which will result in good attitude towards Biology.

### Conclusion

The study concluded that Computer-Based Instructional strategy led to improve students' learning outcomes in Biology in senior secondary schools. Specifically, the study concluded that students taught using Computer-Based Instructional strategy had better performance in Biology, positive attitude towards learning of Biology, and an improved retention, than those taught using the conventional method.

### Recommendations

Based on the findings of the study, the following recommendations were made:

1. Government should, on a large-scale, adopt CBIS as a strategic intervention to raise the quality of science education and tackle the persistent issue of poor academic achievement in both internal and external examinations.
2. Regular trainings, seminars and workshops should be organized to educate and sensitize the teachers on the benefits and usage of Computer-Based Instructional Strategy in teaching Biology.
3. Computer-Based Instructional strategy should be used to teach all categories of students in order to have better performance for all students in Biology in secondary schools.
4. Computer-Based Instructional strategy should be adopted by the teachers in order to enhance students' performance, attitude and retention in Biology in secondary schools.

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## IMPLEMENTATION OF THE NIGERIA CERTIFICATE IN EDUCATION (NCE) PHYSICS CURRICULUM IN SOUTH-WESTERN, NIGERIA

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### Abstract

*This paper views the implementation of the NCE Physics curriculum in Colleges of Education across South-Western Nigeria, with a focus on the alignment between policy intentions and classroom realities. Drawing on teacher education, regulatory provisions of the National Commission for Colleges of Education (NCCE), and observed institutional conditions, the paper interrogates how instructional strategies, laboratory utilisation, assessment practices, and lecturer preparedness shape curriculum delivery. The study reveals persistent gaps between the prescribed curriculum and its implementation, particularly in the areas of practical, learner-centred pedagogy, and skills-based assessment. Inadequate laboratory facilities, limited funding, large class sizes, and uneven professional development opportunities for Physics lecturers further constrain effective implementation. These challenges undermine the curriculum's capacity to produce competent and confident Physics teachers equipped to meet contemporary scientific and technological demands. The paper argues that without deliberate institutional support, monitoring, and periodic curriculum contextualisation, the objectives of the NCE Physics programme will remain largely aspirational. It therefore calls for strengthened regulatory oversight, improved resource provision, targeted capacity building for Physics educators, and reorientation of teaching towards practical competence. The study contributes to ongoing discourse on teacher education reform and provides policy-relevant insights for enhancing the quality of Physics instruction in Nigerian Colleges of Education.*

**Keywords:** NCE Physics curriculum; curriculum implementation; Colleges of Education; Physics teacher education; South-Western Nigeria.

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### Introduction

The development of any nation largely depends on the quality of its education system. This is because a country's goals and values are reflected in and shaped by its educational structure through government policies. The National Policy on Education (NPE) serves as a comprehensive framework that directs the

planning, development, and implementation of education in Nigeria, with the aim of ensuring equitable and high-quality education for all citizens (Federal Ministry of Education, 2019). The NPE seeks to establish a unified and coherent national education system that promotes national identity, cultural values,

and social cohesion (National Council on Education, 2020). It highlights the critical role of education in national development and outlines strategies to enhance access, quality, and relevance across all levels of education (NERDC, 2020). According to national policy documents, education is essential for developing individuals who are capable of understanding their environment and acquiring the knowledge, skills, and competencies necessary for contributing meaningfully to societal and global advancement.

Education, according to Ajayi (2020), is the process of developing individuals to enhance the economic, technological, and social standards of their communities. Similarly, Adebayo (2020) and UNESCO (2020) affirm that education is a fundamental human right and a powerful tool for sustainable development. It enables individuals to acquire the knowledge, skills, and values required for effective participation in society and for adapting to changing conditions. Moreover, Nwosu (2022) views education as a transformation process that empowers people to realize their full potential, question established structures, and contribute to building fairer and more inclusive societies. Education can be broadly defined as the cumulative process through which individuals acquire knowledge, skills, values, and experiences that enable them to function meaningfully and adapt to the demands of life. It is widely acknowledged that the standard of education in a nation is closely linked to its level of socioeconomic development and progress (Salami, 2016, as cited in Olowookere, 2022).

Globally, education serves as a central mechanism for personal and societal development. It contributes to environmental awareness and is instrumental in the transmission, preservation, and transformation of cultural values across generations (Nja & Obi, 2019). Through educational processes, valuable knowledge, competencies, and behavioral patterns are conveyed from one generation to the next, thereby preparing individuals for responsible citizenship and contributing to their intellectual, moral, and social development (Nja, Ukpepi, Edoho, &

Orim, 2019). Education is a multifaceted concept in human life and is not restricted to formal academic instruction; it encompasses both formal and informal modes of learning. It can be viewed as a process, a discipline, or the outcome of organized learning experiences. According to the Cambridge Dictionary (2018), education refers to the act or process of imparting or acquiring knowledge, especially within institutional settings like schools or universities, as well as the learning outcomes gained from this process. As a vital component of human capital, education equips individuals with essential skills and capacities needed to navigate a complex and interdependent world (World Bank, 2022). It plays numerous critical roles in society, which include:

1. Knowledge acquisition: Education enhances understanding of the world and promotes intellectual development (UNESCO, 2020).
2. Skill development: It fosters the acquisition of practical and cognitive skills necessary for career and personal success (World Bank, 2022).
3. Social integration: Education facilitates the internalization of societal norms, values, and social behavior (NCES, 2020).
4. Economic empowerment: It improves individuals' employment prospects and contributes to economic advancement (OECD, 2020).
5. Personal growth: Education promotes critical thinking, creativity, and self-reflection (Nwosu, 2022).
6. zens (United Nations, 2020).

### Statement of the problem

Physics, as a core science subject, plays a crucial role in national development through its contributions to technological advancement, innovation, and scientific literacy. The Nigeria Certificate in Education (NCE) programme is designed to prepare competent teachers who will effectively teach Physics at the basic education level. However, despite the strategic role of the NCE Physics curriculum, there is growing concern about the quality of its implementation in teachers' training colleges, particularly in the Southwest geopolitical zone of Nigeria. Evidence

from research and educational reports suggests that the implementation of the NCE Physics curriculum is fraught with numerous challenges. These include inadequate instructional facilities and laboratories, poor funding, lack of qualified lecturers, outdated teaching methodologies, and limited opportunities for practical, hands-on experiences. Consequently, many NCE Physics graduates appear ill-equipped to handle the demands of teaching Physics effectively in secondary schools, thereby contributing to the persistent low student achievement and interest in the subject.

### **Rationale for Implementation the NCE Physics Curriculum**

The implementation of the Nigeria Certificate in Education (NCE) Physics curriculum is essential for ensuring that the programme fulfil its intended educational purpose. Curriculum evaluation is recognized globally as a **systematic process for assessing relevance, effectiveness, and outcomes** of a prescribed curriculum so that evidence-based improvements can be made to enhance teaching and learning quality. It involves examining curriculum content, instructional methods, learning outcomes, and assessment practices against stated goals and societal needs, thus ensuring alignment with national education objectives and evolving scientific knowledge (Teachers Institute, 2023). In the context of teacher education, particularly science and physics education, curriculum evaluation provides **critical feedback on implementation fidelity**, identifying gaps between design and practice that might hinder the development of competent Physics teachers. Without systematic evaluation, institutions cannot determine whether students are achieving the desired competency levels in Physics content knowledge, practical skills, and pedagogical methods necessary for effective classroom practice. This evidence is crucial for informed decision making by curriculum planners, teacher educators, and regulatory bodies such as the National Commission for Colleges of Education (NCCE, 2020). Moreover, evaluation facilitates **curriculum renewal and responsiveness to contemporary scientific advancements** and educational

demands. Given the rapid evolution of science and technology, it is imperative that the NCE Physics curriculum remains relevant, up-to-date, and capable of preparing teachers for current classroom challenges. Regular evaluation enables the integration of new pedagogical approaches and resources, ensuring that students are not disadvantaged by outdated content or instructional strategies. Evidence from curriculum evaluation studies in Nigeria further underscores this need. Research on the implementation of physics curricula at various education levels has revealed issues such as incomplete delivery of prescribed content, inadequate teaching resources, and challenges in translating curriculum goals into classroom practices. These findings highlight the practical necessity of evaluation as a feedback mechanism to address structural and pedagogical weaknesses that directly affect learner outcomes and teacher preparedness (Teachers Institute, 2023).

### **Conceptual Clarification of Curriculum Implementation**

The concept of curriculum development and implementation is crucial in Nigeria's educational system. Curriculum development refers to the process of designing, implementing, and evaluating educational programs (Egbe, 2020). On the other hand, curriculum implementation refers to the process of putting the developed curriculum into practice (Ogunsola, 2019). In Nigeria, the National Educational Research and Development Council (NERDC) is responsible for developing and implementing the national curriculum (NERDC, 2020). The council works with stakeholders, including teachers, parents, and community leaders, to develop a curriculum that is relevant to the needs of Nigerian students (Adeyemi, 2020). Despite the efforts of NERDC, there are several challenges facing curriculum implementation in Nigeria. One of the major challenges is the lack of adequate resources, including textbooks, equipment, and technology (Olorunsola, 2020). Another challenge is the inadequate training of teachers, which affects their ability to implement the curriculum effectively (Egbe, 2020). To address these challenges, the government needs to

increase funding for education and provide adequate resources for schools (Adeyemi, 2020). Additionally, teachers need to receive regular training and support to enhance their capacity to implement the curriculum effectively (Ogunsola, 2019).

### **Policy and Regulatory Framework Governing NCE Physics**

The National Policy on Education (NPE) in Nigeria is a comprehensive framework that guides the development of education in the country (Federal Republic of Nigeria, 2013). The policy is anchored on Nigeria's philosophy on education, which emphasizes the building of a free and democratic society, a just and egalitarian society, a united and self-reliant nation, a great and dynamic economy, and a land of bright and full opportunities for all citizens (Ogunsola, 2015). In curriculum evaluation, models are essential so as to provide a conceptual framework for designing a particular evaluation depending on the area of evaluation interest. In line with, Ajayi (2020) assumed that models help in examining proximity among components and defining activities, and point ways towards new thinkable applications or research difficulties. Numerous evaluation models have been projected, promulgated, established and recycled by veteran educational evaluator since 1945 to date.

The Nigeria Certificate in Education (NCE) for Physics Education programme is essential in preparing educators to teach Physics at the Senior Secondary Schools level in Nigeria after graduation. Physics education at colleges of education in Nigeria is a theory, principle and calculation based course accompany with practical-followed-up in each topic which required basic knowledge of the organizational concepts and techniques in practical physics skills that is being done under the school of secondary education (sciences), as reflected in the Minimum Standard (NCCE, 2020).

### **Implementation Realities in South-Western Nigeria**

Lecturers' experience is a crucial factor in the effective implementation of the Physics curriculum (Egbe, 2022). Experienced lecturers are more likely to

have a deeper understanding of the subject matter and to be more effective in implementing the curriculum (Adeyemi, 2022). Studies have shown that lecturers with more experience are more likely to use innovative teaching methods, such as problem-based learning and inquiry-based learning, which are effective in promoting student learning outcomes (Ogunsola, 2021). Additionally, experienced lecturers are more likely to be able to adapt the curriculum to meet the needs of diverse learners, which can improve curriculum implementation (Olorunsola, 2022).

However, despite the importance of lecturers' experience, many studies have reported that inexperienced lecturers are often assigned to teach Physics courses, particularly in Nigerian universities (Egbe, 2022). The impact of the educators/lecturers in the performance of the pre-service teachers is germane. The lecturers are the implementers who are to impact into the pre-service teachers the concepts expected to be learnt. The relationship between lecturers and pre-service teachers is a crucial factor in the effective implementation of the Physics curriculum (Egbe, 2022). A positive relationship between lecturers and pre-service teachers can enhance the quality of teacher preparation and improve curriculum implementation (Adeyemi, 2022). Studies have shown that lecturers who have a positive relationship with pre-service teachers are more likely to provide effective guidance and support, which can enhance the quality of teacher preparation (Ogunsola, 2021). Additionally, pre-service teachers who have a positive relationship with lecturers are more likely to be motivated and engaged in the learning process, which can improve curriculum implementation (Olorunsola, 2022).

Tutors should place their students in circumstances where they can make value decisions concerning science-based issues occurring daily. Also, active teachers are those who provide prospects for their students to study the interfaces of science, technology and society in the light of science-based issues important to society. The duty of promoting satisfactory student notion of science is not a stress-free one. Any effort to

realize this goal requires explanation of the nature of science and the scientific creativity. Hence, science is a way of knowing, as well as a body of knowledge. The body of knowledge results from the harsh devotion to a set of rules and values. Moreover, attempts to promote scientific knowledge are hopeless from the start if we, as science teachers' experts, cannot or will not develop such thought in our students. Employment of adequate numbers of skilled educator is a qualification for imparting quality education.

### **Factors Influencing Physics Teaching and Learning**

Physics teaching and learning is a complex process that is influenced by a variety of factors. These factors can be broadly categorized into teacher-related factors, student-related factors, and environmental factors. This literature review aims to examine the factors influencing Physics teaching and learning and identify areas for improvement.

#### ***Teacher-Related Factors***

Teacher-related factors play a significant role in influencing Physics teaching and learning. Teacher Characteristics are a crucial aspect, as they can either facilitate or hinder student learning. Research has shown that teachers' personal characteristics, such as their attitude, motivation, and enthusiasm, can significantly impact student engagement and academic achievement in Physics (Kılız & Uzun, 2019). Teaching Methods and Strategies are another vital factor.

However, Mwoma and Obiero, (2018) added that, teachers' ability to create a supportive and inclusive learning environment can also positively impact student learning outcomes in Physics. Teacher Professional Development is also essential in influencing Physics teaching and learning. Research has highlighted the need for ongoing professional development opportunities for Physics teachers to enhance their subject matter knowledge, pedagogical skills, and technological literacy (Larkin & Richardson, 2017). Teacher-Student Interaction is another critical factor. Studies have shown that positive teacher-student relationships, characterized by

mutual respect, trust, and open communication, can foster a supportive learning environment and promote student engagement and motivation in Physics (Adeyemi, 2017). Research has shown that teacher-related factors, such as teacher qualifications, teacher experience, and teacher motivation, play a significant role in influencing Physics teaching and learning (Adeyegbe, 2020). Okebukola (2019) found out that teachers with higher qualifications and more experience were more effective in teaching Physics. However, another study by Akinyemi (2020) reported that teacher motivation was a significant factor influencing Physics teaching and learning.

#### ***Student-Related Factors***

Student-related factors, such as student motivation, student interest, and student prior knowledge, also play a significant role in influencing Physics teaching and learning (Khan, 2019). For example, a study by Tamir (2019) found that students who were more motivated and interested in Physics tended to perform better in the subject. However, another study by Oyinloye (2020) reported that students' prior knowledge was a significant factor influencing Physics learning outcomes. In addition, Sandbarey, Armstrong and Wischusen (2015), elucidated that enquiry based practical offers students a more accurate knowledge where the answer is not always encoded and which necessitates students to come up with their own ideas from their personal thought.

More so, Eze and Ezemagu (2018) perceived that schools which are involved in hands-on classes perform better in an examination than those that neglect practical work. As revealed by Sandberg (2015), educators were primarily slow to amend their methodologies in Physics but with good result (improved academic performance) and upkeep from national science and educational organizations, there is now development. Eze and Ezemagu (2018) stated categorically that Physics practical has a positive effect on the academic performance of students in Physics examinations.

#### ***Environmental Factors***

Environmental factors play a significant role in the teaching and

learning of Physics. Teachers and educators must be aware of the physical, psychological, technological, and sociocultural factors that can impact students' learning experiences. By creating a supportive, inclusive, and well-designed learning environment, teachers can enhance students' motivation, engagement, and understanding of Physics concepts. The learning environment plays a crucial role in the teaching and learning of Physics in which environmental factors can significantly impact students' motivation, engagement, and understanding of Physics concepts. Environmental factors, such as classroom environment, school resources, and parental involvement, also play a significant role in influencing Physics teaching and learning (Adeyemi, 2020). This agrees with the finding of Ogunniyi (2019) that a positive classroom environment was a significant factor influencing Physics teaching and learning.

The physical environment of the classroom can affect students' learning outcomes. A study by Higgins (2017) found that a well-designed classroom with adequate lighting, temperature, and seating arrangement can improve students' concentration and engagement in Physics lessons. Similarly, Osborne (2018) emphasized the importance of laboratory facilities in teaching Physics, highlighting the need for safe, well-equipped, and well-maintained laboratories. However, another study by Afolabi (2020) reported that school resources, such as laboratory equipment and technology, were significant factors influencing Physics learning outcomes psychologically. The psychological environment of the classroom can also impact students' learning experiences. A study by Duit (2019) found that a supportive and inclusive classroom environment can foster students' motivation and interest in Physics. Furthermore, Kiróly (2020) highlighted the importance of reducing anxiety and stress in Physics classrooms, emphasizing the need for teachers to create a relaxed and encouraging learning environment to be technologically friendly. The technological environment of the classroom can also enhance or hinder students' learning experiences. A study by

Smetana (2017) found that the use of simulations and multimedia resources can improve students' understanding of complex Physics concepts. However, in disagreement a study by Koehler (2019) warned that over-reliance on technology can lead to a lack of depth in students' understanding of Physics concepts without socio-cultural factors inclusion.

The sociocultural environment of the classroom can also impact students' learning experiences. A study by Brown (2018) found that students' cultural backgrounds and prior experiences can influence their understanding of Physics concepts. Furthermore, (Larkin, 2019) highlighted the importance of promoting diversity and inclusion in Physics classrooms, emphasizing the need for teachers to create a welcoming and inclusive learning environment.

#### ***Infrastructural facilities***

Resources such as instructional materials, infrastructure, laboratories, and qualified personnel are vital to providing students with quality Physics education. Several studies have examined the adequacy of these resources in Nigerian Colleges of Education, highlighting both successes and challenge. Instructional materials housing in a standard infrastructural facility are fundamental to practical-based subjects like Physics, where students need to apply theoretical knowledge to real-world scenarios. Adequate resources, including textbooks, audio visual materials, and Physics tools, have been identified as essential for effective learning. However, a study by Olusola and Adeyemi (2020) revealed that many colleges of education in Nigeria face challenges in providing sufficient teaching resources. Most technical and vocational schools in Nigeria do not have laboratories or workshops, let alone usable equipment and facilities and where they exist, they are grossly inadequate, as the laboratories only have the items or equipment that were provided when the Schools were established. It is however most astonishing to know that most technical and vocational schools still depend on roadside artisans' workshops to teach technical and vocational education concepts in this 21st century. This is a total shame and a high degree of

irresponsibility on the part of the function of this programme. The available facilities are inadequate both quantitatively and qualitatively and are also obsolete.

The laboratories only have items or equipment that were provided at the inception of the establishment of the schools. The other 60% do not have laboratory or workshop and that this reflects the low quality of technology programmes in higher institutions. He further noted that these few institutions that have laboratories experience acute shortage in supply of laboratory equipment. He concluded that this situation is partly responsible for the reason why it has been increasingly difficult to run experiments effectively for students and made the teaching and research in science and technology difficult and therefore the country was producing insufficient and ill-prepared physics education graduates necessary for driving the technological and socio-economic development of this nation. The inadequacy in teaching, laboratory and workshop facilities has contributed to the diminution of the quality of technical and vocational education graduates being produced in Nigeria.

### **Challenges and Strategies associated with Curriculum Coverage in Physics**

Curriculum coverage is a critical aspect of Physics education, as it determines the extent to which students are exposed to the subject matter (Egbe, 2020). However, several challenges have been identified as hindering effective curriculum coverage in Physics, including inadequate instructional time, insufficient resources, and poor teacher preparation (Adeyemi, 2020). In Nigeria, for instance, the Physics curriculum is often criticized for being too broad, leading to inadequate coverage of key topics (Ogunsola, 2019). Additionally, the lack of qualified Physics teachers and inadequate laboratory facilities have been identified as major challenges to effective curriculum coverage (Olorunsola, 2020). To address these challenges, several strategies have been proposed, including the use of technology-enhanced instruction, collaborative learning, and project-based learning (Egbe, 2020). Additionally, teacher professional development programs have been recommended as a

way to enhance teacher preparation and improve curriculum coverage (Adeyemi, 2020).

Furthermore, recent studies have emphasized the importance of aligning the Physics curriculum with the needs of the 21st-century workplace, including the development of critical thinking, problem-solving, and communication skills (Ogunsola, 2019). Other challenges are as well highlighted;

1. Curriculum Pacing: Managing time effectively to cover essential content (Hake, 2018).
2. Teacher Support: Providing professional development for effective curriculum implementation (NRC, 2014).
3. Technology Integration: Leveraging digital tools to enhance engagement and understanding (ISTE, 2017).

### **Implications for Teacher Preparation and Science Education**

The implementation of the NCE Physics curriculum has **profound implications for teacher preparation and the broader landscape of science education**. A robust and contextually responsive teacher education system is central to ensuring that prospective Physics teachers are not only knowledgeable but also competent in translating curriculum intentions into effective classroom practice. First, research consistently shows that the **quality of initial teacher preparation influences instructional quality and persistence in teaching**. Well-designed teacher preparation programmes help graduates develop strong content knowledge, effective pedagogical strategies, and the confidence to manage diverse classroom situations all of which are linked with better student outcomes in science subjects (Achurra, Uskola & Zamalloa, 2024). For example, studies from international contexts highlight that secondary mathematics and science teacher preparation programmes significantly shape graduates' instructional quality and their likelihood to remain in the profession, underscoring the need for rigorous preparation in both content and pedagogy. In the Nigerian context, findings from science education research point to **gaps in teacher preparedness** that have serious implications for

achieving the goals of science education. Evaluations of science teacher preparation reveal that inadequate training, lack of continuous professional development, and insufficient engagement with contemporary teaching methodologies contribute to teachers' struggles in delivering practical, inquiry-based learning experiences that are central to the NCE Physics curriculum. These shortcomings can undermine students' understanding of scientific concepts, limit their engagement with practical work, and ultimately hinder the development of scientific literacy a core objective of curriculum reforms. (Achurra et al., 2024).

Furthermore, teacher preparation impacts **science education outcomes beyond individual classrooms**. A strong preparation system fosters reflective practitioners who are more likely to adapt instruction to address local needs, incorporate research-informed practices, and advocate for improved instructional resources. Conversely, weak preparation reinforces traditional, lecture-centred approaches and contributes to persistent challenges such as poor student performance and low interest in science careers. This is especially concerning given Nigeria's aspirations for technological advancement and national development, where science and science education play pivotal roles. In summary, a thorough evaluation of the NCE Physics curriculum's implementation reveals that **teacher preparation is a linchpin for curriculum success**. Strengthening pre-service training, aligning programmes with contemporary science education demands, and expanding ongoing professional learning opportunities are essential to producing competent Physics teachers and improving science education at all levels.

#### Conclusion

This paper has examined the past literature review on the implementation of the Nigeria Certificate in Education (NCE) Physics curriculum with a view to re-positioning it for greater effectiveness in Colleges of Education, particularly within the South-Western region of Nigeria. The discussion has shown that while the curriculum is well articulated in terms of aims and content, significant gaps persist between policy intentions

and classroom practice. These gaps, manifested in limited practical engagement, inadequate instructional resources, and uneven teacher preparedness, continue to undermine the attainment of the curriculum's stated objectives. Re-positioning the NCE Physics curriculum therefore requires moving beyond periodic curriculum review to a more holistic approach that prioritises effective implementation. Central to this is the strengthening of teacher preparation, as the quality of Physics instruction at the basic education level is directly linked to the competence of teachers produced by Colleges of Education. Greater emphasis on inquiry-based teaching, sustained laboratory work, and assessment practices that reflect practical competence is essential if the curriculum is to respond meaningfully to contemporary scientific and technological demands. Furthermore, institutional and regulatory support must be reinforced to ensure fidelity to curriculum standards. Improved funding for laboratories and instructional materials, continuous professional development for Physics lecturers, and systematic monitoring by relevant agencies are critical steps towards aligning curriculum prescriptions with actual practice. Without such coordinated efforts, the NCE Physics curriculum risks remaining largely aspirational, with limited impact on classroom realities and learner outcomes. In conclusion, re-positioning the NCE Physics curriculum for effectiveness is both an educational and developmental imperative. A well-implemented curriculum has the potential to produce confident, competent, and innovative Physics teachers capable of nurturing scientific literacy and problem-solving skills among learners. Achieving this goal demands sustained commitment from policymakers, institutions, and educators to translate curriculum ideals into lived educational experiences that advance science education and national development.

#### Suggestions

The following suggestions were advanced for this study to achieve improved implementation of NCE Physics curriculum;



- i. Strengthening Institutional Support and Monitoring exercise by the government at all levels in collaboration with relevant non-governmental organizations,
- ii. Curriculum Review and Contextualization should be frequently carried out by the stakeholders and curriculum experts,
- iii. Organized capacity building for Physics educators,
- iv. Strengthened regulatory oversight on teaching and learning activities,
- v. Improved resource provision for teaching and learning activities; and
- vi. Reorientation of teaching and assessment towards practical competence.

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## IMPACT OF COVID-19 PANDEMIC ON ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL BIOLOGY STUDENTS' IN EKITI STATE NIGERIA

BY

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### Abstract

*This paper examined impact of COVID-19 pandemic on academic performance of senior secondary school students in Biology in Ekiti State. The study adapted descriptive research of the ex-post facto designs. The population for the study comprised all the senior secondary school students in all the 599 secondary schools spread across the 16 local government Areas of Ekiti State. The sample consisted of 4021 SSS III students selected through multistage sampling procedure from 12 secondary schools across the state. A self-developed proforma was used as the instrument for data collection. The instrument was validated by experts and tested for reliability. The reliability coefficient of 0.79 was obtained using the test re-test method. Four questions were raised and four hypotheses formulated. The data collected through the proforma were analyzed using descriptive and inferential statistics. Findings of the study revealed that there is significant impact of COVID-19 pandemic on secondary school students' academic performance in Biology, there is no significant difference in the impact of COVID-19 pandemic on male and female students' performance in Biology. Based on these findings, it was recommended that educational institutions should consider implementing targeted support programs.*

**Keyword:** COVID-19 pandemic, academic performance, Biology, students, learning environment

### Introduction

The arrival of 2020 comes with the proclamation of COVID-19 as a pandemic, a disease caused by a coronavirus that had spread across the globe. At this time, most developed nations were thrown into confusion as the rate of infection and consequential death keep increasing on daily basis. The COVID-19 pandemic stands out not only as the most several global health crisis in recent memory but also represents the most substantial global security threat faced in a considerable span of time. The virus has spread through every continent of the world since its first appearance. Various opinions were raised as to how to protect individual from contacting the deadly virus since it will take a lengthy time and process to

develop the vaccine or drug to cure the disease. In December 2019, the disease first appeared in Wuhan, China, and never stopped there but spread through the nations of the world. As a result, over one million citizens of both developed and developing countries were murdered by this deadly virus (Velavan & Meyer 2020). It would be recorded COVID is a virus that spreads by droplets in the air and by contacting infected surfaces. Aside from being a health disaster, the pandemic is also a historically unprecedented socio-economic problem. The potential for disastrous social, economic, and political consequences in each every country it affects is momentous, and the consequences will be felt for a long time.

COVID-19, a novel coronavirus disease, made its entry into Ekiti State, Nigeria in line with the global outbreak that began in late 2019. In early 2020, the first cases were reported in Nigeria, and subsequently, Ekiti State recorded its first confirmed case of COVID-19 in March 2020. As the pandemic rapidly spread across the nation. Ekiti State, like other regions, took swift action to contain its transmission. The state government implemented a series of preventive measures, including lockdowns, travel restrictions, closure of public places, and the enforcement of social distancing protocols. Testing centers were established to diagnose cases and contact tracing efforts were intensified to identify and isolate individuals who came into contact with confirmed cases. Health facilities in Ekiti State were mobilised to provide treatment for COVID-19 patients, and public awareness campaigns were launched to educate the populace about the virus and the importance of preventive measures. Ekiti State, like other parts of the world, faced challenges stemming from the pandemic, including disruptions to daily life, economic difficulties, and strain on healthcare resources. Throughout the pandemic, the government collaborated with health agencies, local communities, and other stakeholders to mitigate the impact of COVID-19 and safeguard the well-being of its residents.

Non-pharmaceutical therapies were encouraged to be used in order to avoid some of the symptoms of the resulting disease (Bao, 2020; Velavan & Meyer, 2020). Separation policies reduced social and economic activities. In an environment where not all carriers of the virus display symptoms and testing for the virus are difficult, it is necessary to engage people at risk of harboring virus rather than those who are ill to achieve separation. The government of countries worldwide, notably Nigeria, were forced to proclaim lockdown that range from partial to total lockdown.

This lockdown birthed school closure ranging from primary schools to tertiary institutions in the entirety of Nigeria with

effect from March 23, 2020. The timing was particularly critical as numerous Nigerian schools had just completed their second continuous assessment tests and were gearing up for the second-term examinations. Students who enrolled in certificate classes were also in the midst of preparations for external examinations at that time. Due to the sudden closure of schools, both learners and educators were left without enough time to prepare for the upcoming change. Relevant stakeholders in the education system could not find a quick solution to the problem which lasted for over 24 weeks. This period that separated the teachers and students from physical gathering to interact in the school posed a prodigious challenge to learning generally, science inclusive.

Education has been shown to be a powerful tool for bringing about constructive social change. It has been widely regarded as a means of promoting natural growth in developed and developing countries across the globe. Educational goals are to produce sound and effective members of the society who can live as functional, sensible, and acceptable human beings by developing their heads, heart and hands (3Hs), including both male and female children, to realise their own goals and society as a whole (Adu and Oshati, 2014). For sustainable development, science and technology education serve as the basis for social and economic advancement globally. It is also regarded as one of the most potent instruments for society members to confront and execute their tasks as productive members of the society in the face of ever-changing obstacles and circumstances (Eila, et al., 2017). Science Education in schools help students develop a through comprehension of the subject matter to apply their knowledge in real-world situations (Ayeni, 2016). Science education aims to produce a science-minded populace capable of adapting to a rapidly changing technological and scientific world.

## Purpose of the Study

The purpose of the study was to examine the impact of the COVID-19 pandemic on the academic performance of Senior Secondary School Students in Biology in Ekiti State, Specifically, the study:

1. examined secondary school students' performance in Biology before and after the covid-19 pandemic.
2. investigated the impact of COVID-19 pandemic on male and female students' performance in Biology in Ekiti State.
3. determined the impact of COVID-19 pandemic on public and private school students' performance in Biology in Ekiti.
4. investigated the impact of COVID-19 pandemic on school students' performance in urban and rural areas in Biology in Ekiti State.

## Research Questions

In an attempt to address the research problem, the following research questions were raised and provided answers to:

1. What is the performance of secondary school students in Biology before and after the COVID-19 pandemic?
2. What is the performance of male and female students in Biology before and after the COVID-19 pandemic?
3. What is the performance of public and private school students' in Biology before and after the COVID-19 pandemic?
4. What is the performance of students in rural and urban school in Biology before and after the COVID-19 pandemic?

## Research Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant impact of COVID-19 pandemic on secondary school students' performance in Biology.
2. There is no significant difference in the impact of COVID-19

pandemic on male and female students' performance in Biology.

3. There is no significant difference in the impact of COVID-19 pandemic on students' performance in Biology in public and private school.
4. There is no significant difference in the impact of COVID-19 pandemic on students' performance in Biology in urban and rural school.

## Research Design

The study adopted descriptive research of the ex post facto design. The survey design examined the impact of the COVID-19 pandemic on the academic performance of Senior Secondary School Students in Biology in Ekiti State, Nigeria. The researcher has no direct control over the cause, and thus infer the possibilities of the causes based on the existing effect.

## Population

The population for the study was made up of all the senior secondary school Biology students in all the 599 secondary schools spread across the 16 local Government Areas of Ekiti State. The number of public secondary schools was 219 and private schools was 380 in Ekiti State (Ekiti State Ministry of Education, 2024). The students' in senior secondary school three (SSS 3) were preferred for the study.

## Sample and Sampling Techniques

The study sample encompassed 4,021 senior secondary school (SSS3) Biology students drawn from 12 secondary schools located across Ekiti State. Employing a multi-stage sampling procedure, schools were meticulously chosen from the three senatorial districts. In the initial stage, one local government area was randomly selected from each of the three senatorial districts. The second stage involved the selection of four secondary schools from each of the selected local government areas, using stratified sampling technique, which comprised two public schools (one urban

and one rural) and two private schools (one urban and one rural), considering both the type and location of the schools. The final step involved purposive selection of Biology students who had registered for the West African Examinations Council (WAEC) in the years 2017, 2018, 2019 (pre-COVID-19 pandemic) and 2020, 2021, 2022, (post-COVID-19 pandemic) and had obtained results.

### Research Instrument

The instrument used for the study was tagged the Biology Performance Pro-forma (BPP) designed by the researcher. The pro-forma was employed to collect

**Table 1:** Percentage of students' performance in Biology before and after the COVID-19 pandemic

Category	Performance	Frequency	Percentage
Before COVID - 19	Good	263	6.54
	Average	1,356	33.72
	Poor	534	13.28
After COVID-19	Good	1,239	30.81
	Average	476	11.84
	Poor	153	3.81
<b>TOTAL</b>		<b>4,021</b>	<b>100.00</b>

Table 1 showed the performance of students in Biology before and after the COVID -19 pandemic. Before the pandemic, 263 (6.54%) had good performance, 1,356 (33.72%) had average performance, and 534 (13.28%) had poor performance. After the pandemic, 1,239 (30.81%) had good performance, 476 (11.84%) had average

data on students' WAEC Biology results, gender, school type, and school location from the selected secondary schools in Ekiti State. The grade were then assigned numerical values to derive the Biology Grade point (BGP). A1 was assigned 9 points, B2 as 8 points, B3 as 7 points, C4 as 6 points, C5 as 5 points, C6 as 4 points, D7 as 3 points, E8 as 2 points, and F9 as 1 point.

### Results

**Research Question 1:** What is the performance of secondary school students in Biology before and after the COVID-19 pandemic?

performance and 153 (3.81%) had poor performance. This is an indication that students had better performance after the pandemic than before the pandemic.

**Research Question 2:** What is the performance of male and female students in Biology before and after the COVID -19 pandemic?

**Table 2:** Percentage of male and female students' performance in Biology before and after the COVID -19 pandemic

Performance		Male		Female	
		N	%	N	%
Before COVID -19	Good	118	2.93	145	3.61
	Average	617	15.34	739	18.38
	Poor	243	6.04	291	7.24
After COVID -19	Good	564	14.03	675	16.79
	Average	212	5.27	264	6.57
	Poor	74	1.84	79	1.96
<b>TOTAL</b>		1828	45.46	2193	54.45

Table 2 showed the performance of male and female students before and after the pandemic. Before the pandemic, the table shows that among students with good performance, 118 males constituted 2.93%, whereas females accounted for 145, representing 3.61%. In the category of average performance, 617 males comprised 15.34%, and 739 females constituted 18.38%. Additionally, for students with poor performance, 243 males constituted 6.04%, while 291 females made up 7.24%. For post-pandemic, the table revealed that male

students with good performance increased to 564, constituting 14.03%, with female reaching 675, representing 16.79%. In the average performance category, 212 males comprised 5.27%, and 264 females constituted 6.57%. Furthermore, students with poor performance were 74 males (1.84%) and 79 females (1.96%).

**Research Question3:** What is the performance of public and private school students in Biology before and after the COVID -19 pandemic?

**Table 3:** Percentage of public and private school students' performance in biology before and after the COVID -19 pandemic

Public	Performance		Private		
	%	N	%	N	
Before COVID-19	Good	147	3.66	116	2.88
	Average	512	12.73	844	20.99
	Poor	81	2.01	453	11.27
After COVID-19	Good	659	16.39	580	14.42
	Average	37	0.92	439	10.92

	Poor	22	0.55	131	3.26
1458	<b>TOTAL</b>		36.26	2563	63.74

Table 3 showed the performance of private and public students before and after the pandemic. Prior to the pandemic, students with good academic comprised 147 (3.66%) from private schools and 116 (2.88%) from public schools. Likewise, in the category of average performance, 512 (12.73%) students were from private schools, contrasting with 844 (20.99%) from public schools. Furthermore, for students with poor performance, 81 (2.01%) attended private schools, while 453 (11.27%) were from public schools. For post-pandemic, there was a notable shift, with private school students exhibiting good performance totaling 659 (16.39%),

and public-school counterparts amounting to 580 (14.42%). For the average performance, 37 (0.92%) students were from private schools, while 439 (10.92%) were from public schools. Additionally, students with poor performance comprised 22 (0.55%) from private schools and 131 (3.26%) from public schools. This is an indication that private schools had better BGP mean score than the public schools.

**Research Question 4:** What is the performance of students in rural and urban school in Biology before and after the COVID-19 pandemic?

**Table 4:** Percentage of performance of urban and rural school students in Biology before and after the COVID-19 Pandemic

Performance		Urban			
		Rural		Urban	
%	N	%	N	%	N
Before COVID-19	Good	128	3.18	135	3.36
	Average	682	16.96	674	16.76
	Poor	276	6.86	258	6.42
After COVID-19	Good	639	15.89	600	14.92
	Average	251	6.24	225	5.60
	Poor	77	1.91	76	1.89
<b>TOTAL</b>		2053	51.06	1968	48.94

Table 4 revealed the performance of urban and rural schools' students' before and after the pandemic. It showed that

before the pandemic, students with good performance were 128 (3.18%) from urban schools while those from rural

schools were 135 (3.36%). Also, for the average performance, 682 (16.96%) were from urban schools and 674 (16.76%) from rural schools. In addition, students with poor performance were 276 (6.86%) from urban schools and 258 (6.42%) from rural schools. After the pandemic, urban school students with good performance were 639 (15.89%) while those from rural schools were 600 (14.92%). Also, for the average performance, 251 (6.24%) were from urban schools and 225 (5.60%) were from rural schools. In addition, students

with poor performance were 77 (1.91%) from urban schools and 761 (1.89%) from rural schools. Comparing the differences, there is no substantial difference between urban and rural students' performance before and after the pandemic.

**Hypotheses Testing**

**Hypothesis 1:** There is no significant impact of COVID-19 pandemic on secondary school students' performance in Biology.

**Table 5: ANCOVA of Students' Performance before and after COVID-19 pandemic**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5084.945 <sup>a</sup>	1	5084.945	1282.318	.000
Intercept	122680.319	1	122680.319	30937.433	.000
<b>Group</b>	<b>5084.945</b>	<b>1</b>	<b>5084.945</b>	<b>1282.318</b>	<b>.000</b>
Error	15937.076	4019	3.965		
Total	140789.000	4021			
Corrected Total	21022.020	4020			

a. R Squared= .242 (Adjusted R Squared = .242)

It is evident from Table 5 that there is a significant impact of COVID-19 on secondary school students' performance

in Biology. A significant difference was observed between the performance of students in Biology before and after the COVID-19 pandemic ( $F_{1,4019} = 1282.318$ ,  $p < 0.05$ ).

**Table 6: Pair wise Comparisons of the performance before and after COVID-19 pandemic**

(1)	(J) Conventional	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower	Upper
					Bond	Bond
Collaborative						
Before covid-19	After covid-19	-2.255*	.063	.000	-2.378	-2.131
After covid-19	Before covid-19	-2.255*	.063	.000	-2.131	-2.378

Based on estimated marginal means

\*The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 6 showed that the BGP mean score before the pandemic is lower than the BGP mean score after the pandemic. The BGP mean difference between them is 2.225 which also shows that this

difference is significant ( $p < 0.05$ ) at 0.05 level of significance. This is an indication that the students' performance in Biology after the covid-19 pandemic is better than before the pandemic.

**Hypothesis 2:** There is no significant difference in the impact of COVID-19 pandemic on male and female students' performance in Biology.

**Table 7: ANCOVA of male and female students' performance before and after COVID-19 pandemic**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5086.128 <sup>a</sup>	3	1695.376	427.358	.000
Intercept	121643.099	1	121643.099	30662.879	.000
GROUP	5054.980	1	5054.980	1274.221	.000
GENDER	.116	1	.116	.029	.864
GROUP *GENDER	1.112	1	1.112	.280	.596
Error	15935.892	4017	3.967		
Total	140789.000	4021			
Corrected Total	21022.020	4020			

1. R Squared = .242 (Adjusted R Squared = .241)

Table 7 showed that there is no significant difference between the performance of male and female students in Biology ( $F_{1,4017} = 0.29$ ,  $p > 0.05$ ) at 0.05 level of significance. There was no significant difference in the impact of COVID-19 pandemic on male and female students' performance in Biology. ( $F_{1,4017}$

= .280,  $p > 0.05$ ) at 0.05 level of significance. The null hypothesis was not rejected. Hence, there was no significant difference in the impact of COVID-19 pandemic on male and female students' performance in Biology.

**Hypothesis 3:** There is no significant difference in the impact of COVID-19 pandemic on students' performance in Biology in public and private school.

**Table 8:** ANCOVA of private and public school students' performance before and after COVID-19 Pandemic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6219.247 <sup>a</sup>	3	2073.082	562.082	.000
Intercept	119228.567	1	119228.567	32354.825	.000
GROUP	4401.901	1	4401.901	1194.535	.000
SCHL TYPE	1102.472	1	1102.472	299.176	.000
GROUP* SCHL TYPE	14.754	1	14.754	4.004	.045
Error	14802.774	4017	3.685		
Total	10789.000	4021			
Corrected Total	21022.020	4020			

a. R Squared = .296 (Adjusted R Squared = .295)

Table 8 revealed that there is significant difference between the performance of public and private school students in Biology ( $F_{1,4017} = .299.176$ ,  $p < 0.05$ ) at 0.05 level of significance. Also indicated is that there is significant difference in the impact of COVID-19 pandemic on public and private school

students' performance in Biology.  $F_{1,4017} = 4.004$ ,  $p < 0.05$ ) at 0.05 level of significance. The null hypothesis was rejected. Hence, there was significant difference in the impact of COVID-19 pandemic on students' performance in Biology in public and private school. This implies that the COVID-19 pandemic impact on the performance of secondary school students' in Biology favoured one particular school type than the other.

**Table 9:** Pairwise Comparisons of the performance of private and public schools

(I) Collaboration	(J) Conventional	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>	95% Confidence Interval for Difference <sup>b</sup>	
					Lower Bound	Upper Bound
Private	Public	1.095*	.063	.000	.971	1.220
Public	Private	-1.095*	.063	.000	-1.220	-.971

Based on estimated marginal means

\* The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 9 showed that the BGP means score of private school is higher than that of the public school. The BGP mean difference between them was 1.095 which also shows that this

difference is significant ( $p < 0.05$ ). This is an indication that the students' performance in Biology private school is better than the public school.

**Hypothesis 4:** There is no significant difference in the impact of COVID-19 pandemic on students' performance in Biology in urban and rural school.

**Table 10:** ANCOVA of urban and rural school students' performance before and after COVID-19 Pandemic

Source	Type III Sum of Square	df	Mean Square	F	Sig.
Corrected Model	5103.204	3	1170.068	429.22	.000
Intercept	122556.865	1	122556.865	30926.354	.000
GROUP	5081.795	1	5081.795	1282.355	.000
SCHL LOCATION	2.867	1	2.867	.724	.395
GROUP* SCHL LOCATION	14.371	1	14.371	3.626	0.57
Error	15918.816	4017	3.963		
Total	140789.000	4021			
Correction Total	21022.020	4020			

a. R Squared = .243 (Adjusted R Squared = .242)

Table 10 shows that there is no significant difference between the

performance of urban and rural school students in biology ( $F_{1,4017} = .724$ ,  $p > 0.05$ ) at 0.05 level of significance. There is no significant difference in the impact of COVID -19 pandemic on urban and

rural school students' performance in Biology. ( $F_{1,4017} = 3.626$ ,  $p > 0.05$ ) at 0.05 level of significance. The null hypothesis was not rejected. Hence, there was no significant difference in the impact of COVID-19 pandemic on students' performance in Biology in urban and rural school.

## Discussion

The finding of the study indicated that there was a significant impact of COVID-19 pandemic on secondary school students' performance in Biology. The observed significant impact of the COVID-19 pandemic on secondary school students' performance in Biology aligns with the broader challenges faced that gave rise to pedagogical approaches adopted by educational systems worldwide during this unprecedented health crisis. The closure of schools, disruptions in regular classroom activities, and the transition to remote or hybrid learning models likely contributed to the academic performance of students'. This finding supports Hebecci, Bertiz and Alan (2020) submission that COVID-19 pandemic had a favourable impact on students' academic performance. Conversely, the finding of the study contradicts Oyinloye (2020) and Abiona and Falebita (2020) who concluded that the long break and school closure had a detrimental impact on students' performance. Through the performance considered by the scholars in the sampled schools and region were from the internal examination conducted immediately schools resumed from the long break.

The findings of the study also revealed that there was no significant difference in impact of COVID-19 pandemic on male and female students' performance in Biology. Notably, the significant difference in the impact of the pandemic not found on male and female students' performance in Biology suggests that, at least in the context of Biology education, both genders experienced a similar level of disruption and adaptation challenges. This finding underscores the importance of gender-neutral educational strategies and the need for inclusive support measure during periods of upheaval.

Also, the finding of the study revealed that there was significant difference in the impact of COVID-19 pandemic on students' performance in Biology in public and private school. by Harry (2016) who argued that private schools have resources and are funded, have parents and guardians with higher socio-economic class than their counterparts in the public, and are more involved in their children's education welfare while he pointed out that public schools have more professionally trained and qualified teachers than private schools. On the contrary, Alimi, Ehinola and Alabi (2012) reported that though there is a significant difference in facilities available in public and private schools, and despite this, no significant difference in academic performance of students existed in the two types of secondary schools.

## Conclusion

The study underscores the substantial impact of the COVID-19 pandemic on the academic performance of secondary school students' specifically in the field of Biology. It was concluded that a significant overall improved performance, indicating that the disruptions caused by the pandemic have had a notable and consistent influence on students' performance in Biology. Also, it was concluded that gender does not bring any difference in the impact of the pandemic on students' performance in Biology. This suggests that both genders have experienced a similar level of challenge and disruption in adapting to the new learning environment shaped by the pandemic.

## Recommendations

Based on the findings of the study, the following recommendations were made:

1. Educational institutions should consider implementing targeted support programs. These programs could include additional tutoring and innovative teaching methods to address the specific challenges students face in adapting to the new learning environment shaped by the pandemic.
2. Policymakers and educational authorities should design and



- implement interventions that specifically addressed the challenges faced by students in public schools. This may involve additional resources, professional development for educators, and strategies to bridge the gap in performance between public and private institutions.
3. Teachers and school authority should continually promote gender-neutral educational strategies. Ensuring that both male and female students' have equal access to resources, support, and opportunities will contribute to a more inclusive and equitable educational environment.

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# LECTURER'S PERCEPTION ON THE CONTENT KNOWLEDGE SUITABILITY AND APTNESS OF ENTREPRENEURIAL EDUCATION CURRICULUM AND GRADUAND EXPLOIT FOR SELF-EMPLOYMENT IN NIGERIA TEACHER EDUCATION PROGRAMME

BY

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## Abstract

*Entrepreneurship Education is very vital owing to its capacity to sustain economic growth; hence, the Federal Government pays special attention to the subsector through various initiatives. This paper, therefore x-rayed lecturers' perception on the suitability and aptness of entrepreneurial education curriculum content, knowledge, and graduand exploit for self-reliance roles as embedded in the Nigerian Colleges of Education Minimum Standard blueprint. All Colleges of Education in Nigeria formed the population for the study, using a multistage sampling procedure. All Federal Colleges of Education in the South-west geo-political zones formed a sample for the study, while a purposive sampling technique was used to select Principal Lecturers and Chief Lecturers in General Studies Education (GSE) where the courses were domiciled, to form the focus group. A mixed research design was adopted. Average weighted mean was used, and themes generated from the open-ended questionnaire were coded into subthemes, nodes, and analyzed using Nvivo 11 statistics. Findings revealed that content knowledge as sequenced and packaged was inadequate and incongruous, as self-employment roles therein are just theoretical as graduates are deficient in content application. It is recommended that the entrepreneurial education content, knowledge, and self-reliance skills curriculum prescribed should cut across all Nigeria Certificate in Education level till graduation, as against the present arrangement.*

**Keywords:** Entrepreneurial Education, Teacher Education, Graduand, Suitability and Aptness of Curriculum, Self-employment

## Introduction

Entrepreneurial Education is considered a lifelong learning process that shapes competitiveness within any economy. The emphasis of entrepreneurial education is on starting, growing, and running a business. The primary purpose of entrepreneurial education curriculum is to develop in the learner's entrepreneurial capacities and mindsets which would assist graduand recognize business opportunities, mobilize resources, and exploit the opportunity for self-employment. However, In fulfillment of one of the goals of education in Nigeria as stated in the National Policy on Education (NPE, 2013), that the development of appropriate skills such as mental, physical, social abilities and competencies to empower the individual to live in and contribute positively to the

society, the Federal Government as a way of providing functional education to meet the needs, yearning and aspiration of Nigerian in global competitiveness through the Federal Ministry of Education and National Commission for Colleges of Education (NCCE) made entrepreneurship education as one of the compulsory General Studies for students in Colleges of Education nationwide as the value system has change due to transition from school to work and to earn a living.

The General Studies Education in tertiary education is designed to expose students to a variety of knowledge across disciplines. It is aimed at enabling students to appreciate the inter-relationship among disciplines in an integrated world, which is fast becoming one big village. Advances in science and

technology are daily breaking down traditional boundaries in human knowledge and communication. General Studies Education (GSE), therefore, offers the potential for bridging gaps in human knowledge, thereby preparing the students to meet the challenges of the changing world adequately. At the Colleges of Education level, the Introduction to Entrepreneurship Education GSE 224 curricula offered are aimed at empowering the graduand with appropriate approaches for self-employment, self-reliance, poverty reduction, making a viable feasibility study of a business idea, wealth creation strategies, different funding windows, digital marketing, and being equipped with fundamental business law. (NCCE, 2020)

Teacher education procedures were designed to equip prospective teachers with the content knowledge, attitude, behaviors, and skills they require to perform their tasks effectively in the classroom, school, local, and wider society. Content refers to the bodies of organized worthwhile knowledge that consist of skills, concepts, values, facts, ideas, principles, theories, generalizations, and techniques that have been accumulated over time in a particular field of study, which learners need to be exposed to in school.

Entrepreneurial Education comprises three interrelated objectives: to produce enterprising graduates, enabling graduates to become effective learners and practitioners, and to generate students who are motivated, self-driven, and prepared to start and develop successful businesses (Oyebode, 2021). Ereh, Anthony and Ikpo, (2019) and Emmanuel; Peter & (Dodo, 2020) in their separate studies established that students have not acquire basic entrepreneurial skills such as creativity, innovation, problem solving, time management skills so as to be useful to themselves, and the society after graduation, therefore, this study seek to find out the suitability and aptness of Entrepreneurship Education curriculum towards NCE graduand self-sustainable drive

### **Objective of the Study**

The main objective of this study was to critically examine entrepreneurial education curriculum content knowledge as domiciled in the School of General Studies Education (GSE) in Colleges of Education. However, the study is guided by the following specific objectives.

- i. Find out lecturers' perception on the suitability of entrepreneurship education curriculum content knowledge for graduates acquiring self-employment skills as presented
- ii. Find out lecturers' perception on the aptness of the transacted curriculum on graduand acquisition of wealth creation skills as prescribed
- iii. Find out the causes of discrepancies between the prescribed and transacted curriculum

### **Research Questions**

The following research questions guide the study

- i. How do Lecturers perceive the suitability of entrepreneurship education curriculum content knowledge as a tool for building self-employment capacity in Colleges of Education graduates?
- ii. How do Lecturers perceive the aptness of the transacted entrepreneurial education curriculum on Colleges of Education graduates' wealth creation skills acquisition?

### **Methodology**

The study used a mixed research design that involved using techniques such as open-ended and structured questionnaires to obtain statistics and information about lecturers' perception on the suitability and aptness of entrepreneurship education curriculum content knowledge towards graduate entrepreneurship capacity building in self-employment and wealth creation skills. Average weighted means through structured questionnaires and thematic analysis converted into nodes from respondents' reactions to open-ended questionnaires form the basis for decision making. All academic staff in Colleges of Education in Nigeria formed the population for the study, while all Federal Colleges of Education in the South-West geo-political zones formed the sample for the study. Purposively, stratification based on School and lecturers' ranks was used to select the

School of General Studies, while Principal Lecturers and Chief Lecturers as focusing groups. School of General Studies was selected because the course is domiciled herein, while Principal Lecturer and Chief Lecturers handling the course were selected because of their accumulated wealth of experience.

Open-ended instruments titled “Perception of Lecturers on the Suitability and Aptness of Entrepreneurship Curriculum Content Knowledge”. (PLSAECCK) was used to collect data from the focus group in the Department of General Studies Education. The second instrument measures discrepancies using the average weighted mean and standard deviation. Face and content validity for the instrument was determined through

expert’s advice in measurement and evaluation. Item-by-item analysis of the questions was done to remove unnecessary questions, while the reliability of an instrument was assessed through Cronbach's alpha statistics, which shows the extent to which the results obtained from an instrument can be relied upon as the true measure. Internal consistency values were 0.72 and 0.76, respectively.

**Results**

RQ 1: How do Lecturers perceive the suitability of entrepreneurship education curriculum content knowledge as a tool for building self-employment capacity among the graduates of Colleges of Education?

**Table 1: Summary of responses of focus group on lecturer’s perception of the suitability of entrepreneurial education curriculum content, knowledge, and graduand self-employment capacity**

Respondent	content suitability	Respondents
R2	inadequate	R1
R4	unsuitable	R3
R6	not related	R8
R7	disconnected from objective	R12
R5	not practical oriented	
R9	ambiguously packaged	
R10	not adequate enough	
R11	inappropriate	
R13	not relevant	

Focus group constituent tagged R2, R4, R6, R7, R5, R9, R10, R11, and R13 perceived entrepreneurial education curriculum content knowledge in relation to graduand self-employment capacity at the Colleges of Education in Nigeria as inadequate, unsuitable, not related, disconnected from main objectives, not practically oriented, ambiguously packaged, not adequate enough, inappropriate and not appropriate respectively. However, R1, R3, R8, and R12 perceived entrepreneurial education curriculum content knowledge in relation to graduand self-employment capacity at the Colleges of Education in Nigeria as

Fig 1: Causes of discrepancies between prescribed and transacted entrepreneurial education curriculum content knowledge in Colleges of Education as perceived by the focus group

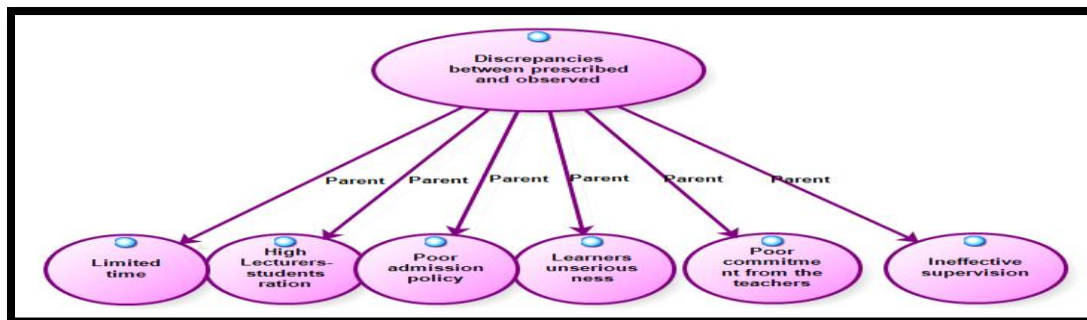


Table 2: Average weighted mean score on the suitability of the entrepreneurial curriculum content knowledge, and graduand self-employment capacity as perceived by the focus group in the Department of General Studies Education in Nigerian Colleges of Education

S/N	Suitability of entrepreneurial curriculum content knowledge as perceived by the focus group in the GSE department	Mean	Std.	Remarks
1	Entrepreneurship Education curriculum is suitable in assisting students to develop key competencies in writing a real business plan and business execution	1.39	.61	SE
2	assisting students to develop competencies in Small and the Medium Enterprises ideology framework	2.18	.69	LE
3	equipping students to develop skills in conducting feasibility study on business master plan	0.92	.53	VSE
4	providing graduates with SWOT principles in business	1.27	.66	SE
5	prepare students with technicality of e-marketing strategies	0.74	.52	VSE
6	expose student to the practical application of wealth creation	0.68	.50	VSE
7	expose student to business venture experience attachment	0.95	.54	VSE
8	equipping students with skills in creating a brand, trademark, service delivery model and intellectual property right	1.37	.63	SE
9	assist student in developing competencies in financial book keeping, final account, and bank reconciliation	2.60	.75	LE
10	expose student to business funding institutions in Nigeria	2.84	.79	LE
	<b>Average Weighted Score</b>	<b>1.49</b>		<b>SE</b>

**Benchmark for average weighted mean scores:** From 4.0 to 3.1 Very Large Extent (VLE); From 3.0 to 2.1 Large Extent (LE); From 2.0 to 1.1 Small Extent (SE), and from 1.0 to 0.1 Very Small Extent (VSE)

Table 2 revealed that 13 Principal Lecturers and Chief Lecturers are the respondents that formed the focus group, while the cumulative findings revealed that, to a small extent, entrepreneurial

curriculum content knowledge in Colleges of Education is suitable for self-employment as the mean score was 1.49, which falls within the rating scale of from 2.0 to 1.1, indicating a small extent yardstick.

**RQ2:** How do Lecturers perceive the aptness of the transacted entrepreneurial education curriculum content on Colleges of Education graduand wealth creation skills acquisition?

**Table: 3**  
Summary of responses by the focus group on the aptness of entrepreneurial education curriculum content, knowledge, and graduand wealth creation capacity

Respondents	Inaptness	Respondents
R2	not closely	R1
R3	not orderly	R5
R4	unsuitable	R11
R6	not appropriate	
R7	disjointedly sequenced	
R8	deficiency in practical content	
R9	incorrect	
R10	not incompatible	
R12	incongruity	
R13	unmatched	

Focus group with code R2, R3, R4, R6, R7, R8, R9, R10, R12 and R13 perceived entrepreneurial education curriculum content knowledge towards graduand acquiring wealth creation capacity in Colleges of Education as not closely related, not orderly placed, unsuitable, not appropriate, disjointedly sequenced, deficiency in practical content, incorrect, incompatible, incongruity and unmatched respectively while on the other hand R1, R5 and R11 perceived entrepreneurial education curriculum content knowledge towards graduand acquiring wealth creation capacity in Colleges of Education as apposite, related and suitable for the accomplishment of the predetermined ideas.

**Table 4: Average weighted mean scores on the aptness, entrepreneurial education curriculum content knowledge, and graduand wealth creation capacity as perceived by the focus group in the Department of General Studies Education in Nigerian Colleges of Education**

S/N	Aptness of the entrepreneurial curriculum content for graduate to possess wealth creation capacity					Mean	Std.	Remarks
a.	Evaluation	of	business	ideas		2.43	.58	LE
b.	procedure	for	starting	an	enterprise	1.20	.51	SE
c.	common	problem	of	SMEs		2.24	.52	LE
d.	feasibility	study	and	study	plan	1.53	.51	SE
e.	harnessing	SWOT		principles		1.25	.50	SE
f.	final account	and	relevant	financial	documents	0.88	.44	VSE
g.	marketing			strategies		2.62	.53	LE
h.	business	regulatory	and	supervisory	laws	1.50	.52	SE
i.	Dynamism		in	e-marketing		1.90	.53	SE
j.	Business		funding	institution		2.23	.57	LE
k.	Intellectual		property	right		2.21	.56	LE
<b>Average Weighted Mean Score</b>						<b>1.81</b>		<b>SE</b>

**Benchmark:** From 3.1 to 4.0 Very Large Extent (VLE); From 2.1 to 3.0 Large Extent (LE); From 1.1 to 2.0 Small Extent (SE), and from 0.1 to 1.0 Very Small Extent (VSE)

Table 4 above revealed average weighted mean scores for all 13 respondents who are the participant and the focus group for the study. The questionnaire was designed to seek the perception of the targeted sample on the aptness of the entrepreneurial education curriculum, content knowledge, and graduates' wealth creation capacity. The results revealed that the curriculum content of Introduction to Entrepreneurship, as contained in the NCCE minimum standard, is just to a small extent appropriate to equip graduates with

wealth creation capabilities because the average weighted mean score of the small extent range stood at (1.10 to 2.00) and the average weighted mean score calculated was 1.81, which is within the small extent threshold.

#### Discussion of findings

The study revealed that the suitability of the entrepreneurial education curriculum content knowledge to achieve graduand self-employment capacity is just to a small extent feasible with a value of average weighted mean of 1.49 while respondents perceived the items within the course content as inadequate, disjointly sequenced and incompatible in themes and orientation as there is a disconnection between content prescribed and curriculum transacted owing to poor

supervision within and from the supervisory agencies. The findings of this study is agreement with Oyebode (2021), who established that the content and method of implementing entrepreneurship education curriculum are inadequate towards solving graduate unemployment confronting the nation. The findings of this study are consistent with the findings of Israel and Israel (2020), where it was established that the NCE curriculum is overcrowded and overloaded with activities and programmes in their core teaching subject area, hence transacted content was affected negatively. The finding of the study also aligned with Ereh, Anthony & Ikpo (2020) where it was established that despite the established roles of the tertiary institutions and emphasis by the federal government on entrepreneurship education, it seems students have not still been able to acquire the basic skills such as, creativity, innovation, and problem-solving, time management and communication skills, to become useful to themselves or the society after graduating from school. On the contrary, the finding of this study is not in agreement with Oseni (2017), who earlier reported that entrepreneurship education curriculum is adequate as it prepare graduand to acquire variety of skills that can make them to be responsible and enterprising individuals by engaging themselves in real life learning experiences where they can take risk, manage the results and learn from the outcomes.

The study further revealed that introduction to entrepreneurship content knowledge in Colleges of Education lacks practical orientation, which further buttresses earlier findings of Olorundare & David (2014) and Hafiz (2015). However Okolocha & Ifeanyi (2021) found out curriculum content were adequate for the acquisition of entrepreneurial capacities as perceived by students in College of Education in Edo and Delta State as the standard deviation of all the course titles and curriculum contents for the acquisition of entrepreneurship skills range from 0.33 to 0.96 with an overall standard deviation of 0.65 showing that the standard deviation for all course titles are

within the same range indicating that the respondents are not wide apart in their mean ratings

Focus group labelled R2, R4, R6, R7, R5, R9, R10, R11, and R13 perceived entrepreneurial education curriculum content knowledge in relation to graduand self-employment capacity at the Colleges of Education in Nigeria as not suitable because it is shallow in practical content and orientation. The respondents identify limited time with overloaded course content, instructional facilities deficit, high student-teacher ratio at the GSE unit, poor admission policy, unseriousness on the part of the learners and ineffective internal and external supervision as the causes of discrepancies between preset and transacted curriculum

The study further revealed inaptness of the introduction to entrepreneurship (GSE 224) curriculum towards graduate wealth creation capacity skills in Colleges of Education as preset. The outcome of this study substantiates the findings of Amos & Onifade (2018) and Mwinjuma, (2020), where it was established that introduction to entrepreneurship content points to many deficiencies about educators, learning environments, curriculum inappropriateness, teaching processes, and availability of instructional materials. The findings of the study also support earlier studies by Isa & Jaana (2018), where it was stated that it is a widespread knowledge that entrepreneurship education in pre-service teacher training is either absent, inappropriately and inaptly outlined or insufficiently executed. Isa & Jaana (2018) further stated that the results are quite normal because neither educators nor the current learning environments have adequate backgrounds and or infrastructures to put entrepreneurship into practice

Focus group with code R2, R3, R4, R6, R7, R8, R9, R10, R12, and R13 perceived entrepreneurial education curriculum content knowledge towards graduates acquiring wealth creation capacity in Colleges of Education as inappropriate in terms of themes and direction. The findings are in line with earlier studies by Ossai & Nwalado

(2018) where it was established that to achieve wealth creation skills, it requires actions within and outside the school system, not only content-knowledge driven. Within the school, a supportive environment needs to be created which will enable lecturers to put into practice their entrepreneurial education experience; and outside the school, mechanisms need to be put in place to facilitate the structured involvement of the entire community, businesses, social enterprises, and parents, as in-service teachers are frequently unprepared in terms of both theoretical knowledge and in-classroom experience. The findings of this study also corroborate the earlier position held by Oyeboode (2021) where it was established that there is a need to revise the entrepreneurship curricula so that they include practical application of concepts on the specifics of enterprise and entrepreneurial skills development for pre-service teachers rather than broad-based general entrepreneurship courses. This process will help distinguish between Education for Entrepreneurship that is generic and Entrepreneurship for Education that is specifics

### Conclusion

The urgent need to embrace entrepreneurship education is recognized by the Government across the board, as the Nation's economy depends on new generations of entrepreneurs who must come up with ideas and make them a reality. The motive for the introduction of entrepreneurship education curriculum into tertiary education curriculum was to reinforce youth empowerment and harness graduate potential and intellectual creativity for job creation. The focus group perception on the suitability of entrepreneurship education curriculum content knowledge for graduand self-employment capacity through qualitative and quantitative approaches revealed that the curriculum content knowledge is not suitable enough as the content is deficient in themes sequencing and orientation while discrepancies exist between preset and taught curriculum owing to limited lecture hour, overloaded course content, high teacher-students ratio, poor admission policy at the

teacher training colleges, learners unseriousness, instructional facilities deficits and ineffective internal and external supervision. On the aptness of the course content to inculcate in graduates' wealth creation capacity as the core mandate of entrepreneurship education, the study discovered that the items listed on the course outline are not adequate to achieve wealth creation capacity in graduates as it must involve the institution, host community, Government, and parents

### Recommendations

Based on the findings, discussion, and conclusion of the study, the following are recommended

- I. Practical application of themes, concepts, and thoughts should be incorporated into the (GSE 224) curriculum sequentially
- II. Centre for Entrepreneurship Education be established within the College to monitor the implementation of Introduction to Entrepreneurship Education (GSE 224) domiciled in the School of General Studies Education
- III. Course content of Introduction to Entrepreneurship (GSE 224) needed to be reviewed to reflect the needs of society and those of preservice teachers across levels

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# INFLUENCE OF ROAD SIGN AWARENESS AND COMPLIANCE ON ROAD ACCIDENTS AMONG PEDESTRIANS AND VEHICLE OPERATORS IN ADAMAWA STATE, NIGERIA.

BY

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## Abstract

*Road accidents remain a serious public health challenge in Nigeria, with poor awareness and compliance with road signs a significant contributory factor. This study investigated the influence of road sign awareness and compliance on the incidence of road accidents among pedestrians and vehicle operators in Adamawa State. Using a cross-sectional design, data were collected from 400 respondents via structured questionnaires and analyzed using descriptive and inferential statistics. Results show that the majority of respondents demonstrated low awareness and poor compliance with road signage, and these deficiencies were significantly associated with higher self-reported road accident involvement. Recommendations include enhanced public education, targeted enforcement, and improved signage visibility.*

**Keywords:** Road sign awareness, compliance, road accidents, pedestrians, vehicle operators, Adamawa State

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## Introduction

Road traffic accidents remain one of the leading causes of injury, disability, and premature death globally, posing significant public health and socio-economic challenges. According to the World Health Organization (WHO, 2023), approximately 1.19 million people die annually because of road traffic crashes, with low- and middle-income countries accounting for over 90% of these fatalities. Despite having only about 60% of the world's vehicles, these countries experience a disproportionately high burden of road traffic injuries. This situation reflects the combined effects of inadequate infrastructure, weak enforcement of traffic regulations, limited public awareness, and risky road user behaviors.

In Nigeria, the problem of road traffic accidents has persisted despite various policy interventions and the establishment of regulatory agencies such as the Federal Road Safety Corps (FRSC). Available reports indicate that thousands of lives are lost yearly on Nigerian roads, with many more individuals suffering

permanent injuries and economic hardship (FRSC, 2022). Human factors, including ignorance of traffic rules, reckless driving, speeding, and non-compliance with road signs, have been consistently identified as major contributors to road crashes across the country (Abdulkareem et al., 2019; Okenwa et al., 2024). Among these factors, road sign awareness and compliance play a critical role in shaping road user behavior and traffic safety outcomes.

Road signs are essential components of traffic management systems designed to provide regulatory instructions, warnings of potential hazards, and guidance information to road users. They function as visual communication tools that promote orderly traffic flow and reduce conflicts between vehicles and pedestrians (Shetty et al., 2024). When road users understand and obey traffic signs, they are better equipped to anticipate road conditions, adjust driving behavior, and make safe crossing decisions. Conversely, inadequate awareness or disregard for

road signs often leads to unsafe practices such as speeding, illegal overtaking, ignoring pedestrian crossings, and failure to obey traffic signals, all of which increase the likelihood of accidents.

Despite the importance of road signs, empirical evidence suggests that many road users in Nigeria exhibit limited knowledge of traffic signs and low compliance with traffic regulations. Anene (2022) reported that a significant proportion of Nigerian drivers are unable to correctly interpret standard traffic symbols, while Abdulkareem et al. (2019) found widespread non-compliance with traffic signals among commercial drivers in northern Nigeria. Similar patterns have been observed among pedestrians, who frequently ignore designated crossing points and traffic signals, thereby exposing themselves to serious injury risks (Uyeh-Nwaezeigwe, 2024). These findings suggest that the effectiveness of road signage in improving traffic safety is compromised by behavioral and knowledge-related challenges.

Adamawa State, located in northeastern Nigeria, has experienced increasing road traffic activity due to urban expansion, commercial transportation growth, and population mobility. Major towns such as Yola, Mubi, and Jimeta serve as transportation hubs connecting neighboring states and international routes. However, the growing volume of road users has not been matched by proportional improvements in traffic safety education and compliance enforcement. Reports from road safety authorities and local studies indicate that road accidents remain frequent in the state, with pedestrians and commercial vehicle operators among the most affected groups (Musa et al., 2021). Factors such as poor road sign visibility, limited public sensitization, weak enforcement, and inadequate driver training further exacerbate the problem. Although several studies have examined road safety issues in Nigeria, there remains a limited body of empirical research focusing specifically on the combined influence of road sign awareness and compliance on accident occurrence in Adamawa State. Most existing studies concentrate on major metropolitan areas such as Lagos, Abuja,

and Port Harcourt, leaving a research gap in northeastern Nigeria where traffic patterns, socio-economic conditions, and infrastructural challenges differ significantly. Understanding the level of awareness and compliance among both pedestrians and vehicle operators in this region is essential for developing context-specific interventions that can effectively reduce accident rates.

Against this background, the present study investigated the influence of road sign awareness and compliance on road accident occurrence among pedestrians and vehicle operators in Adamawa State. By examining the extent of road sign knowledge, compliance behavior, and their relationship with accident involvement, this study seeks to provide empirical evidence that can inform traffic safety policies, educational programs, and enforcement strategies. The findings are expected to contribute to the growing body of literature on road safety in Nigeria and offer practical recommendations for improving road user behavior and reducing traffic-related injuries and fatalities in the state.

Road traffic accidents (RTAs) are a major cause of injury, disability that sometimes leads to death worldwide. In Nigeria for instance, the incidence remains high despite efforts by authorities to mitigate them through policies and enforcement. Road signs are critical communication tools that inform road users about regulatory, warning, and guidance information aimed at reducing crashes. Effective signage and road traffic regulation compliance reduce misinterpretation and risky behaviours (Dewi, 2025). However, studies in Nigeria and elsewhere have documented limited awareness and compliance with road signs among drivers and pedestrians. For example, research in Southern Nigeria found out that there is low understanding of traffic signs and symbols among drivers, with implications for safety (Anene, 2022). A study in Obafemi Awolowo University community reported that even where awareness was moderate, actual compliance was low among pedestrians (Uyeh-Nwaezeigwe, 2024). In some Nigerian cities, non-compliance remains a recognized driver of accidents (Abdulkareem et al., 2019).

These studies highlight the need to understand the local dynamics of awareness and compliance in parts of Nigeria such as Adamawa State.

#### **Research Question:**

The following research questions were used to guide the study

1. What is the level of road sign awareness among pedestrians and vehicle operators in Adamawa State?
2. What is the level of compliance with road signs among pedestrians and vehicle operators in Adamawa State?
3. What is the relationship between road signage, drivers' awareness, compliance with traffic rules and the occurrence of road accident in Adamawa State.
4. What is the relationship between road sign awareness and road accident occurrence in Adamawa State

#### **Research hypotheses:**

The following hypothesis were tested at 0.05 level of significance

1. There is no significant relationship between road sign awareness and road accident occurrence among pedestrians and vehicle operators in Adamawa State.
2. There is no significant relationship between road sign compliance and road accident occurrence among pedestrians and vehicle operators in Adamawa State.

#### **Literature Review**

The review was made based on conceptual, empirical, and theoretical perspectives.

#### **Concept of Road Signs and Traffic Safety**

Essentially, road signs are visual communication tools designed to regulate traffic flow, warn road users of potential hazards, and provide guidance for safe navigation. According to Shetty et al. (2024), traffic signs serve as critical safety instruments that support orderly road usage and reduce conflict between road users. Proper interpretation of traffic signs allows drivers and pedestrians to make informed decisions that minimize accident risks. Road sign awareness refers to the ability of road users to recognize, interpret, and understand traffic symbols and instructions. Compliance, on the other hand, involves the actual adherence to the instructions conveyed by these signs. Anene (2022) emphasized that awareness alone is insufficient without

compliance, as behavioral response determines the safety outcome. Studies consistently demonstrate that inadequate comprehension of signs and disregard for traffic regulations increase the likelihood of accidents. Road signage is a core and basic component of traffic safety management systems. Effective signs communicate hazards, regulatory information, and navigational guidance quickly and clearly to all road users (Dewi, 2025). Comprehension and familiarity with signs directly influence compliance, which in turn affects accident rates (Case Studies on Transport Policy, 2020).

#### **Road Sign Awareness and Compliance in Nigeria**

Some empirical evidence from Nigeria suggests that road sign awareness and compliance remain a big problem. Ezeifeka and Ogbogu (2025) observed that many Nigerian drivers struggle to interpret standardized traffic symbols due to limited training, literacy barriers, and inadequate public education. Their findings revealed that misinterpretation of signs often results in improper driving decisions, contributing to crash occurrence. Similarly, a study assessing signage awareness among Nigerian motorists found that less than half of respondents demonstrated adequate knowledge of common traffic signs, with educational background and driving experience significantly influencing comprehension levels (IJAEM, 2022). This suggests that awareness disparities exist across population groups, further complicating traffic safety outcomes.

Okenwa et al. (2024) investigated the attitude of commercial drivers in Enugu State and reported low recognition and interpretation of regulatory signs. The study established a direct relationship between poor sign comprehension and risky driving behaviors such as speeding, wrong overtaking, and failure to observe stop signs. These unsafe practices were identified as major contributors to accident involvement among commercial drivers.

In northern Nigeria for instance, Abdulkareem et al. (2019) found widespread non-compliance with traffic lights and road signs among commercial vehicle operators in Kaduna State. The

authors reported that disregard for traffic control devices significantly increased the frequency of road crashes, especially at busy intersections and highways. These findings reflect a broader national trend of weak enforcement and poor traffic discipline.

Several studies in Nigeria reported that there are significant gaps in drivers' recognition and interpretation of traffic signs. For instance, commercial drivers in Enugu exhibited poor recognition of standard road signs, a factor identified with unsafe driving behavior and accident risk (Okenwa et al., 2024). Similarly, non-compliance with traffic signs and light signals was identified as a leading cause of crashes among commercial drivers in Kaduna State (Abdulkareem et al., 2019). International research underscores that unfamiliarity and misinterpretation of traffic signs are closely linked to non-compliance and crashes (Case Studies on Transport Policy, 2020). A study in the Philippines found that improved visibility and community involvement enhance compliance and reduce accidents (Bermudo & Rabacal, 2025).

Another study was conducted in Adamawa State metropolitan which further supported this pattern. Musa et al. (2021) identified human factors such as ignorance of traffic rules and non-compliance with signage as primary causes of road accidents. The study emphasized that despite the presence of road signs, many road users fail to adhere to traffic regulations, resulting in preventable crashes.

### **Pedestrian Awareness and Compliance with Road Signs**

Pedestrians constitute a vulnerable category of road users whose safety depends largely on their awareness and compliance with traffic signs. Uyeh-Nwaezeigwe (2024) examined pedestrian behavior in a university community and found that although a large proportion of respondents were aware of road signs, actual compliance was significantly lower. Many pedestrians crossed roads at undesignated points and ignored pedestrian crossing signs, increasing exposure to traffic hazards. This big gap between awareness and practice highlights the behavioral dimension of

traffic safety. According to Shetty et al. (2024), behavioral attitudes, perceived risk, and enforcement visibility strongly influence whether road users comply with traffic regulations. Without consistent enforcement and education, pedestrians often underestimate the dangers associated with non-compliance.

### **Global Perspectives on Road Sign Awareness and Compliance**

Some international studies confirm that road sign awareness and compliance are essential determinants of traffic safety outcomes. A systematic review conducted by Hassan et al. (2025) revealed that age, driving experience, and education significantly influence traffic sign comprehension and accident involvement. Younger and less experienced drivers were found to exhibit lower compliance rates and higher crash involvement compared to older drivers.

In India for instance, Shetty et al. (2024) reported that poor adherence to traffic rules and weak understanding of signage were major contributors to urban road accidents. Similarly, studies in Pakistan observed that although students demonstrated moderate awareness of road signs, risky behaviors such as speeding and crossing without observing signals remained prevalent (Khan et al., 2021). These international findings align with Nigerian studies, suggesting that poor awareness and compliance represent a global challenge that requires integrated policy interventions involving education, enforcement, and infrastructure improvement.

### **Structural and Enforcement Challenges**

Apart from individual behavior, infrastructural and institutional factors play a significant role in shaping compliance outcomes. Enimola (2022) reported that inadequate placement, vandalization, and poor maintenance of road signs in Nigeria reduce their effectiveness. In many locations, faded or obstructed signs fail to convey critical information, leading to confusion among road users. Weak enforcement further compounds the problem. According to Independent Newspaper (2024), limited manpower, corruption, and inconsistent traffic monitoring undermine compliance efforts. Road safety experts argue that public education campaigns must be

supported by strict enforcement measures to achieve sustainable behavioral change.

### **Theoretical Link Between Awareness, Compliance, and Road Safety**

The relationship between awareness, compliance, and road accident occurrence can be explained using behavioral and risk perception theories. These theories suggested that individuals who possess adequate knowledge of traffic signs are more likely to comply with safety regulations and avoid risky behavior. However, when awareness is low or enforcement is weak, road users may develop negative attitudes toward traffic rules, leading to habitual violations and increased accident risk (Hassan et al., 2025). This theoretical linkage supports the argument that improving awareness without addressing compliance behavior may produce limited safety outcomes. Effective road safety interventions must therefore target both cognitive understanding and behavioral enforcement.

The literature reviewed indicated that road sign awareness and compliance significantly influence road safety outcomes. Studies conducted in Nigeria and other countries consistently shows that low awareness and poor compliance contribute to high accident rates. Structural challenges such as inadequate signage and weak enforcement further exacerbate the problem. These findings justify the need for localized studies such

as the present research in Adamawa State to generate evidence-based solutions tailored to specific traffic environments.

### **Methodology**

A descriptive cross-sectional survey was employed to assess road sign awareness, compliance behaviour, and road accident involvement among pedestrians and vehicle operators. The study was conducted in Adamawa State, Nigeria, encompassing selected urban and rural areas with diverse road traffic patterns. A total of 400 respondents (200 vehicle operators and 200 pedestrians) participated. Participants were selected through multistage sampling across two urban and two rural LGAs. Additionally, 30 traffic safety officers were engaged to provide contextual data on accident patterns and enforcement. Data were collected using a structured questionnaire and interviews. The questionnaire captured demographics, awareness of road signs, compliance behaviors, and accident involvement. Data were analyzed with SPSS. Descriptive statistics (frequencies, means) described awareness and compliance levels. Inferential statistics (Pearson correlation, regression) examined relationships between variables.

### **Results and Discussion.**

**Research Question 1:** What is the level of road sign awareness among pedestrians and vehicle operators in Adamawa State?

**Table 1: Frequency and Percentage on Distribution of road sign awareness among vehicle operators in Adamawa State**

Awareness Level	Frequency	Percentage (%)
Low Awareness	238	59.5
Moderate Awareness	102	25.5
High Awareness	60	15.0
<b>Total</b>	<b>400</b>	<b>100</b>

Results in table 1 shows that 59.5% of respondents demonstrated low awareness of road signs, while only 15% showed high awareness. This indicates a major knowledge gap among road users in Adamawa State. Descriptive statistics were used to analyze respondents' awareness of road signs. Based on the result is presented in Table 1. The findings show that 238 respondents (59.5%) demonstrated low awareness,

while 102 respondents (25.5%) had moderate awareness, and only 60 respondents (15.0%) exhibited high awareness of road signs. This indicates that the majority of road users in Adamawa State lack adequate knowledge and understanding of road signs, which may negatively affect safe road usage. The level of road sign awareness among pedestrians and vehicle operators in Adamawa State is generally low. This finding agrees with that of Ezeifeka and

Ogbogu (2025) who observed that many Nigerian drivers struggle to interpret standardized traffic symbols due to limited training, literacy barriers, and inadequate public education.

**Research Question 2:** What is the level of compliance with road signs among pedestrians and vehicle operators in Adamawa State?

**Table 2: Frequency and Percentage on Distribution of Road Sign Compliance Levels**

Compliance Level	Frequency	Percentage (%)
Low Compliance	256	64.0
Moderate Compliance	94	23.5
High Compliance	50	12.5
<b>Total</b>	<b>400</b>	<b>100</b>

Result in table 2 revealed that 64% of respondents exhibited low compliance with road signs. This confirms widespread disregard for traffic regulations among both drivers and pedestrians. The results indicated that 256 respondents (64.0%) showed low compliance with road signs, while 94 respondents (23.5%) demonstrated moderate compliance, and only 50 respondents (12.5%) reported high compliance. This finding suggests that most road users frequently violate traffic regulations, including speed limits, pedestrian crossings, and stop signs, which increases the risk of road traffic accidents. This means that compliance with road signs among pedestrians and vehicle operators in Adamawa State is

poor and unsatisfactory. This finding agrees with the observation of Uyeh-Nwaezeigwe (2024) who examined pedestrian behavior in a university community and found that although a large proportion of respondents were aware of road signs, actual compliance was significantly lower. Many pedestrians crossed roads at undesignated points and ignored pedestrian crossing signs, increasing exposure to traffic hazards

**Research Question 3:** What is the relationship between road signage, driver's awareness, compliance with traffic rules, and the occurrence of road accidents in Adamawa SFretate?

**Table 3: Frequency and Percentage of Road Accident Experience**

Response	Frequency	Percentage (%)
Yes	271	67.8
No	129	32.2
<b>Total</b>	<b>400</b>	<b>100</b>

The result in table 3 revealed that approximately 68% of respondents reported involvement in or exposure to road accidents, indicating a high accident prevalence in the study area. This finding

signifies that most of the road users had experiences on road accidents but still they are not being careful regarding compliance.

**Research Question 4:** To what extent is road sign awareness and road accident occurrence in Adamawa State?

**Table 4: Correlation between road sign awareness and road accident occurrence**

Variables	r
Awareness vs Accident Rate	-0.481
p-value	.000

The result shows that there is a moderate negative correlation between road sign awareness and accident occurrence ( $r = -0.481$ ,  $p < .05$ ). This means that as awareness increases, accident involvement decreases significantly. The analysis revealed a

moderate negative correlation between road sign awareness and accident occurrence ( $r = -0.481$ ,  $p < .05$ ). This indicates that as awareness of road signs increases, the rate of accident involvement decreases significantly. Similarly, a strong negative correlation

was found between road sign compliance and accident occurrence ( $r = -0.563$ ,  $p < .05$ ). This shows that improved compliance behavior significantly reduces road accident risks. There is a significant inverse relationship between road sign awareness, compliance, and road accident

occurrence. Higher awareness and better compliance lead to fewer accidents. This finding agrees with that of Abdulkareem et al. (2019) who found out that the more aware people are with road sign the lesser the chances of road accidents.

**Table 5: Correlation between road sign compliance and accident occurrence**

Variables	r	p-value
Compliance vs Accident Rate	-0.563	.000

This result shows that there is a strong negative relationship exists between compliance and accident occurrence ( $r = -0.563$ ). This implies that poor compliance contributes significantly to accident rates.

Multiple regression analysis was conducted to determine the predictive influence of awareness and compliance on road accidents

**Table 6: Multiple Regression Analysis Showing Predictors of Road Accidents**

Predictor	B	Std Error	Beta	t	p
Constant	2.814	.193	—	14.58	.000
Awareness	-.317	.062	-.352	-5.11	.000
Compliance	-.428	.058	-.471	-7.38	.000

The regression model shows that: Awareness and compliance together explain 41.2% of the variation in road accident occurrence.

Compliance level ( $\beta = -0.471$ ) is the strongest predictor of accident reduction. Both variables significantly predict accident occurrence at  $p < .05$ .

This confirms that poor awareness and low compliance significantly increase road accident risks in Adamawa State.

**Hypothesis 1:** There is no significant relationship between road sign awareness and road accident occurrence among pedestrians and vehicle operators in Adamawa State.

Decision rule: Reject hypothesis 1 if  $p$ -value  $< 0.05$ .

From Table 4  $r = -0.481$   $p = .000 (< .05)$

The finding revealed that there is a statistically significant relationship between road sign awareness and road accident occurrence based on the result. Lower awareness levels significantly increase accident risk. Therefore, H01 was rejected.

**Hypothesis 2:** There is no significant relationship between road sign compliance and road accident occurrence among pedestrians and vehicle operators in Adamawa State.

Decision Rule: Reject Hypothesis 2 if  $p$ -value  $< 0.05$ .

Result on table 5 shows that  $r = -0.563$   $p = .000 (< .05)$

This means that road sign compliance has a significant influence on accident occurrence. Poor compliance contributes substantially to higher accident rates among road users in Adamawa State. Therefore, H02 was rejected.

### Conclusion

This study confirms that low awareness and poor compliance with road signs are common among pedestrians and vehicle operators in Adamawa State, contributing to unsafe road behaviours and higher accident incidence. These findings are supported by local and national evidence indicating that inadequate understanding of traffic signs and non-compliance exacerbate crash risk (Okenwa et al., 2024; Abdulkareem et al., 2019). Moreover, the Nigerian context of inadequate signage and enforcement, as reported by road safety advocates, compounds these challenges (Independent Newspaper, 2024). The study demonstrates a clear link between road sign awareness, compliance behaviour, and road accident involvement in Adamawa State. Efforts to address these gaps through education, enforcement,

and infrastructure improvements are urgent.

### Recommendations

Based on the outcome of the study, the following recommendation are proffered

1. There should be road safety Education through mass campaigns targeting both drivers and pedestrians on the meaning and importance of road signs.
2. There should be improved signage to enhance visibility, maintenance, and placement of road signs.
3. Enforcement should be strengthened on traffic compliance to deter violations.

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## BILATERAL TESTICULAR MICROLITHIASIS IN AN 11YEAR OLD BOY – CASE REPORT

BY

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### Abstract

*Testicular microlithiasis is an uncommon finding on scrotal ultrasound, particularly in children and is often seen incidentally whilst examining the scrotum on account of scrotal pain or undescended testis. The prognosis of testicular microlithiasis with infertility and malignancy increases with age and comorbid scrotal findings. Testicular pain and reduction in testicular volume may be related to the presence of testicular microlithiasis which is bilateral and of the classical type in the index case.*

**Keywords:** microlithiasis, testis, scrotal ultrasound, testicular volume

### Introduction

Testicular microlithiasis is characterized by the presence of microcalcifications in the testes often found incidentally on scrotal ultrasonography(Wilson et al. 2024), the microcalcifications or microliths usually measures 1-3mm with no posterior acoustic shadowing(Dudar 2018) and are spherical or ovoid and often bilateral(Dudar 2018, Yu et al. 2020). Testicular microlithiasis is described as the deposition of calcium in the seminiferous tubules and identified on scrotal ultrasound as punctuate non shadowing echogenic foci (Yu et al. 2020, A't Hoen et al. 2021).

The microliths can be diffusely spread throughout the testes known as the diffused type or concentrated in one area

the focal testicular microlithiasis(Trout et al. 2017, Dudar 2018), unilateral or bilateral(Trout et al. 2017). The classification of testicular microlithiasis is limited when there are less than 5 echogenic foci in both testes and classic when there are 5 or more echogenic foci in one or both testes(Wang et al. 2015, Dudar 2018, Yu et al. 2020, Januś et al. 2023). The incidence of testicular microlithiasis in paediatric population is about 2%(Marin et al. 2023), the prevalence in boys is between 0.7% and 3.8%(Trout et al. 2017), being higher in patients with Down syndrome, Klinefelter syndrome and Undescended testis (Sağ and Başar 2023).

Sonography is the diagnostic modality of choice for testicular microlithiasis and was first described in 1987 by Doherty and coworkers (Dudar 2018). The index case of bilateral testicular microlithiasis of the classic type was found incidentally on scrotal ultrasound on account of scrotal pain, while the epididymis was discovered to be slightly enlarged and heterogenous suggestive of Epididymitis.

### CASE REPORT

The index case is 11yr old male adolescent who presented to the general outpatient clinic with sudden pain in the

scrotum, no postural change of pain on examination of both testes, there is no other genitourinary symptoms. Patient denied any history of trauma to the scrotum or penile discharge in the past before presentation.

After clinical evaluation and examination patient was requested to do some investigations including testicular ultrasound. Ultrasound shows multiple punctate calcifications in both testicular parenchyma (figures 1 and 2), with bilateral reduction in testicular volume (figures 3 and 4).

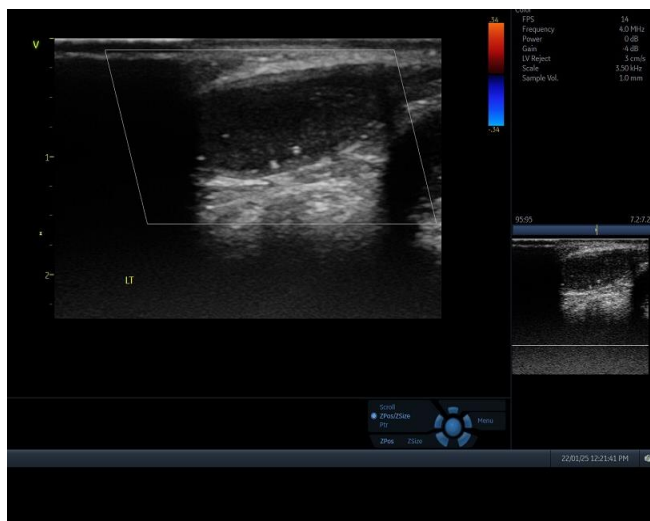


Figure 1: Longitudinal ultrasound showing testicular microlithiasis (classic) with multiple small punctate calcifications of varying sizes in the left testicular parenchyma.

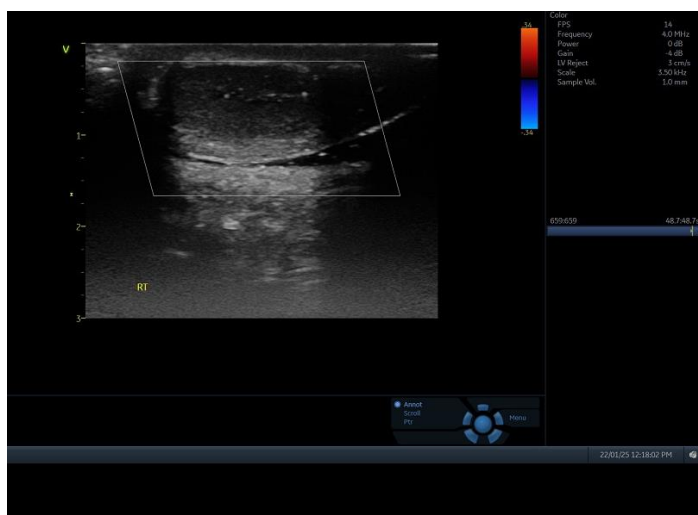


Figure 2: Longitudinal ultrasound scan showing testicular microlithiasis (classic) with multiple punctate calcifications in the right testicular parenchyma.

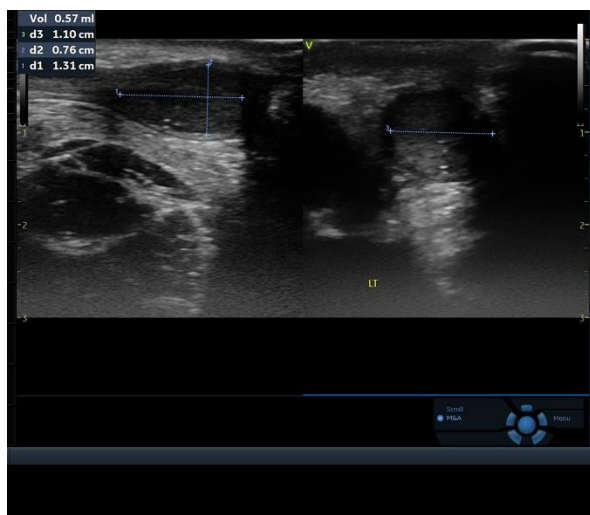


Figure 3: Longitudinal and transverse ultrasound scan of the left testis showing reduced left testicular volume.

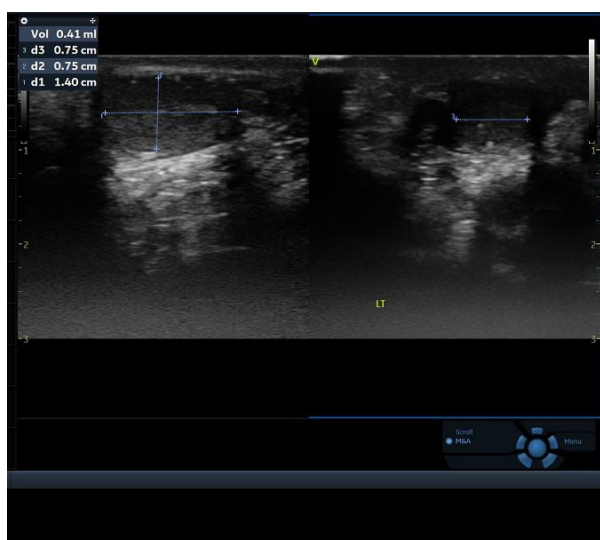


Figure 4: Longitudinal and transverse ultrasound scans showing reduced right testicular volume

## Discussion

The aetiology of testicular microlithiasis is unknown, however suggested causative mechanisms include defective phagocytosis by sertoli cells(Leblanc et al. 2018, Januś et al. 2023), abnormal gonadal embryogenesis, trauma and genetic mutations in some individuals(Wilson et al. 2024).

The dysfunction of sertoli cells leads to accumulation of cellular debris in the testicular lumen with impaired germ cell differentiation and spermatogenesis(Aoun et al. 2019), followed by deposition of glycoproteins which eventually result in

dystrophic calcifications and resultant laminated calcification(Dudar 2018)

The microscopic findings of testicular microlithiasis are of two types, haematoxylin bodies and lamellated calcifications(Balawender et al. 2018, Wilson et al. 2024), and these calcifications are composed of hydroxyapatite that are seen in the seminiferous tubules(Leblanc et al. 2018, Wilson et al. 2024).

Testicular microlithiasis can be graded into i(mild), ii(moderate), iii(severe) with

respect to the number of microliths in each testis, 5-10 microliths is grade i, 10-20 microliths is grade ii and more than 20 microliths is grade iii (Marte et al. 2017, Leblanc et al. 2018, Chaka et al. 2021, Marin et al. 2023).

Testicular ultrasound is the imaging modality of choice for diagnosis of testicular microlithiasis. Hydroxyapatite is responsible for the non shadowing echoes on the testicular parenchyma on ultrasound (Yilmaz et al. 2024). Magnetic resonance imaging of the scrotum can be used in children with suspicious finding on ultrasonography, location of undescended testis and to exclude coexisting testicular lesions.

Hormonal analysis can also be used as a complementary diagnostic tool. The serum levels of follicle stimulating hormone (FSH), luteinizing hormone (LH), testosterone as well as testicular volume can be used to evaluate the spermatogenic function of the testicles because the testicular volume may be lower in boys with testicular microlithiasis (Zolak and Lizkan 2022).

Testicular biopsy may be considered in children with coexisting testicular lesions and associated risk factors because of its invasive nature and psychological impact (Chaka et al. 2021). The management consideration for testicular microlithiasis depends on patient age, clinical presentation and sonographic findings (Yilmaz et al. 2024). The index case was reviewed by the urologist and conservative management was instituted with ultrasonographic follow up advised.

The prognosis of testicular microlithiasis is favourable when it is unilateral, limited, focal, and mild in classification and grading respectively, however the probability of testicular cancer increases when testicular microlithiasis is bilateral and there are coexisting risk factors such as cryptorchidism, gonadal dysgenesis, germ cell tumour and syndromes like Down's, Klinefelter, Peutz-Jeghers and McCune-Albright (Dudar 2018, Yilmaz et al. 2024).

## Recommendations

The transition between adolescent and young adult is a target age to develop testicular cancer hence follow up is recommended in children with testicular microlithiasis. Routine monthly testicular ultrasound is advised for children with coexisting risk factors. Tumour markers such as alpha-fetoprotein (AFP) and beta Human chorionic gonadotropin (bHCG) in symptomatic children with testicular microlithiasis to exclude mitotic lesion.

In those children with isolated testicular microlithiasis reassurance of the child and family and regular testicular ultrasound follow up is recommended. Magnetic resonance imaging of the scrotum may be considered to exclude associated risk factors as well as for follow up of children with diffuse, severe bilateral testicular microlithiasis.

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## EFFECTS OF WHATSAPP LEARNING PLATFORM ON UNDERGRADUATES' PERFORMANCE IN BIOLOGY EDUCATION IN ONDO STATE, NIGERIA.

BY

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### Abstract

This study examined the effects of the WhatsApp Learning Platform on undergraduates' performance in Biology in Ondo State Nigeria. The need for innovative learning and technological-driven learning methods has become increasingly important as conventional teaching methods often limit students' engagement. This study determined whether WhatsApp could enhance Biology students' academic performance compared to traditional instruction. A quasi-experimental design involving pre-test, post-test and control group was adopted. The population consisted of 1,219 Biology Education undergraduates, with a purposive sample of 200 students drawn from two public universities. The Biology Performance Test was used for data collection, with validity ensured through experts review and reliability confirmed with coefficients of 0.82. Data were analyzed using descriptive statistics, t-tests, and ANCOVA at 0.05 level of significance. The findings revealed that students exposed to WhatsApp showed significant improvement in Biology performance. Gender did not significantly influence the effect of WhatsApp on students' performance. The study concluded that WhatsApp, when integrated into instruction, serves as an effective supplementary tool that enhances students' academic performance in Biology. It was recommended that lecturers should embrace mobile learning platforms like WhatsApp to complement classroom instruction and institutions should provide professional development for teachers on digital learning tools.

**Keywords:** Performance, WhatsApp, Treatment, Platform

### Introduction

#### Background to the Study

The world is rapidly transforming due to advancements in science and technology. In today's society, it is increasingly difficult to live without technology, as many individuals rely on gadgets such as mobile phones, tablets, and computers for their daily activities. Social networking platforms have become deeply ingrained in everyday life, with many people finding it challenging to go even a single day without using them. As technology evolves at an unprecedented pace, innovations once considered unrealistic are now part of daily reality. WhatsApp, for example, is a widely used application on mobile devices and computers,

originally designed for the exchange of instructions and entertainment content (Etim, Udosen, & Ema, 2016).

The Nigerian educational system operates within a structured framework comprising primary, secondary, and tertiary levels, designed to produce skilled individuals capable of contributing to the nation's socio-economic development. However, the sector faces persistent challenges such as inadequate infrastructure, limited funding, and regional disparities in access to quality education (Ogunleye, 2020). In response, the government has implemented policies aimed at improving teacher training, enhancing the provision

of educational materials, and expanding access to digital resources. These realities underscore the urgent need for innovative and sustainable solutions to enhance accessibility, quality, and efficiency in the system, particularly as student populations continue to grow.

The sciences which include Biology, Chemistry, Physics, and Mathematics are central to Nigeria's educational curriculum and essential to the nation's advancement in health, technology, and agriculture. Despite their importance, science education in Nigeria faces persistent challenges, including inadequate laboratory facilities, outdated equipment, and insufficient funding for research and development (Ajayi & Banjo, 2021). These limitations often hinder students' engagement with scientific concepts at a practical level, which is particularly critical for disciplines like biology that rely on hands-on learning for deep understanding. Efforts to address these gaps have included partnerships with international organizations to strengthen science infrastructure in schools and universities; however, systemic reforms remain necessary to align Nigerian science education with global standards. Emerging trends in digital learning, such as mobile and online resources, present promising opportunities to complement traditional science instruction (Owolabi and Julia, 2020).

Biology is the science of life and living organisms, encompassing their structure, function, growth, evolution, distribution, and taxonomy (Campbell et al., 2018). It is among the most popular science subjects in Nigerian secondary schools, serving as a gateway to careers in medicine, pharmacy, and dentistry. As a natural science, it integrates disciplines such as anatomy, ecology, and zoology, making it a vital component of general education. Nevertheless, both teachers and students often struggle with certain biological concepts, including genetics, respiration, ecology, photosynthesis, and evolution (West African Examination Council, 2016). The complex and often abstract nature of biology presents unique challenges to student engagement. Effective learning in this subject requires practical activities, visual aids, and

interactive approaches to help students grasp intricate biological processes (Johnson et al., 2019). Digital platforms like WhatsApp, with their multimedia-sharing capabilities, provide educators with tools to deliver diverse and engaging content that supports various learning styles.

Social networking refers to the sharing of stories or information with the intention of influencing others (Mistar & Embi, 2016). Among the many social networking tools, WhatsApp has become particularly prominent. Although the application has been available for several years, recent updates have enhanced its functionality since its initial release. Designed primarily to replace SMS, WhatsApp operates on internet data plans and is compatible with various devices, including Android, iPhone, Windows Phone, Nokia, and Blackberry. As an educational technology tool, social media promotes meaningful, qualitative interactions between learners and teachers, with WhatsApp serving as one of the most widely used platforms in this regard (Okereke, 2014). Social media platforms enable users to connect with friends and family, share multimedia content such as photos, videos, and music, and exchange personal information with a broad audience. They also have positive impacts on communication, collaboration, and social relationships (Bashir & Bhat, 2017). WhatsApp is particularly user-friendly: once a device's phone number is entered, the application (with the user's permission) scans contacts to identify other users, enabling easy invitations and message exchanges. The accessibility of learning materials anytime, anywhere, and in multiple formats through platforms like WhatsApp offers significant potential for enhancing students' deep learning capabilities. Furthermore, it can influence students' attitudes defined as an individual's predisposition toward a person, object, or concept, which may be positive or negative and reflected in beliefs, feelings, or intended behaviours (Donnie, Bambang, Ahmed, & Nur, 2018).

Teaching has been described in various ways by scholars. Zhang (2022) defines it as a form of interpersonal influence

aimed at changing another person's behavioral potential. Learning, on the other hand, is fundamentally about change whether through developing a new skill, understanding a scientific principle, or altering an attitude. Unlike incidental or natural changes, such as those that occur with aging, learning is typically intentional and relatively permanent. While some learning can happen without formal planning through experience, for example it generally involves a conscious effort to remember, understand, and improve future performance.

Active learning, should involves direct engagement with course materials through activities such as discussions, debates, role-playing, and hands-on practice. Beyond the classroom, it can also occur through internships, service-learning projects, and reflective assignments that encourage interaction and critical thinking. Students' expectations are complex constructs that can shape their adaptability, engagement, academic achievement, satisfaction, and retention. Tomlinson et al. (2022) note that students often value teachers who teach clearly, use relevant examples, and incorporate humor into their instruction. The transfer of learning the application of acquired knowledge and skills to new situations depends on multiple factors, including the learner's mental capacity and the degree to which principles can be generalized across contexts.

The corona virus disease 2019 (COVID-19) is a highly transmissible and pathogenic viral infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first identified in Wuhan, China, in December 2019, before rapidly spreading worldwide (Shereen et al., 2020). The outbreak affected all aspects of global life, including communities and academic institutions in Indonesia. On January 30, 2020, the World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC) after cases were reported outside Wuhan and the pandemic quickly escalated, resulting in tens of thousands of confirmed cases in China within weeks and continuing to rise globally (Myzo, 2017). This

unprecedented health crisis posed significant challenges to education systems, necessitating urgent policy interventions to adapt teaching and learning models (Report, 2020). At Maulana Malik Ibrahim State Islamic University Malang, for example, traditional face-to-face instruction was replaced with online and distance learning modalities to ensure academic continuity during campus closures. In response to the emergency, the Indonesian government issued directives through university policymakers to transition teaching activities online, utilizing internet-based platforms to curb the spread of the virus. This strategy aligned with UNESCO's global initiative to support countries in mitigating the educational impact of school closures, particularly for vulnerable and disadvantaged groups, by promoting the use of distance learning to sustain education for all (Green et al., 2021).

In line with Pratama and Yusro (2016), the findings of this study will not only contribute to the growing body of knowledge on social media enhanced learning but also provides practical insight for educators, curriculum planners, policy makers and school management on how to effectively utilized social media tools like WhatsApp to improve teaching and learning in Nigeria Universities.

### **Purpose of the Study**

The purpose of this study was to investigate the effects of whatsapp learning platform on learning outcomes of undergraduates in biology education in Ondo State, Nigeria. The study specifically;

- 1 Investigates the performance of undergraduates in Biology before and after exposure to the WhatsApp Learning Platform and the Conventional Method;
- 2 Determine the difference in performance of undergraduates taught using the WhatsApp Learning Platform and those taught using the Conventional Method in Biology;
- 3 Examine the interactive effects of the WhatsApp Learning Platform and gender on undergraduates' performance in Biology.

## Research Question

The following research question questions were raised to guide this study:

1. What is the performance of undergraduates in Biology before and after exposure to Whatsapp learning platform and conventional method?

## Research Hypotheses

The following hypotheses were formulated and tested in this study:

1. There is no significant difference in the performance of undergraduates in the experimental and control groups before exposure to treatment in Biology.
2. There is no significant difference in the performance of undergraduates taught using the WhatsApp Learning Platform and those taught using the Conventional Method in Biology.

## Methodology

This study adopted quasi-experimental research of the pre-test, post-test and control group design. The design examined the effects of independent variable on the dependent variable.

Academic performance of the students were established by pre-test which was conducted on both the experimental group and control group to ascertain the homogeneity. Post-test will be conducted after the treatments had been administered to measure the effect of the treatment on the performance of the student in both experimental and control group.

While the control group was exposed to convectional teaching method the experimental group on the other hand was exposed to treatment using Whatsapp learning platform (WLP). The population for the study consisted of

**Table 1: Means and Standard Deviation of performance of students in Biology before and after treatment**

Group	N	Mean	SD	Mean	SD	Mean Difference
Whatsapp Learning Platform	108	55.20	8.50	75.60	7.20	20.40
Conventional Method	92	54.80	7.90	68.50	8.10	13.70

Table 1 reveals that undergraduate students exposed to both the WhatsApp Learning Platform and the Conventional Method showed improvement in their Biology performance after treatment. For the WhatsApp Learning

5720 undergraduates in 200Level studying Biology Education in all the Public University in South-West, Nigeria. The choice of 200Level Biology education students seems to be more appropriate because they will be readily available for the treatment. The study sample consisted of 200 undergraduate students at the 200 level, drawn from two public universities in South-West Nigeria. A purposive sampling technique was employed in selecting the sample. The two universities were chosen because they offered BIO 205 as part of their biology curriculum, with little or no variation in course content and academic calendar. Purposive sampling was considered appropriate as it ensured the selection of a sample that was directly relevant to the study objectives and had uniform exposure to the course. The research instrument employed to generate data for the study is Biology Performance Test (BPT). The BPT was used to assess the performance of undergraduates in biology. It consisted of 30 single-answer questions drawn from the course outline for Introductory Developmental and Cell Biology (BIO 205). The test was administered within twenty minutes, with each correct response awarded one mark, giving a maximum obtainable score of 30, which served as a measure of students' performance in biology.

## Results

This section presents the results of the study under the following tables.

**Research Question 1:** What is the performance of undergraduates in Biology before and after exposure to Whatsapp learning platform and conventional method?

**Testing of Hypotheses**

**Hypothesis 1:** There is no significant difference in the performance of

undergraduates in the experimental and control groups before exposure to treatment in Biology.

**Table 3: t-test analysis of the difference in the performance of undergraduates in the experimental and control groups before exposure to treatment in Biology**

Group	N	Mean	SD	Df	T	p
Whatsapp Learning Platform	108	55.20	8.50	198	0.34	0.73
Conventional Method	92	54.80	7.90			

**p>0.05 (Not Significant)**

Table 3 shows that before the treatment, the WhatsApp Learning Platform group had a mean performance score of 55.20 (SD = 8.50), while the Conventional Method group had a mean score of 54.80 (SD = 7.90). The t-test result (t = 0.34, df = 198, p = 0.73) indicates that the difference between the two groups was not statistically significant (p > 0.05). This means that both groups were comparable in their Biology

performance at the pre-test stage, supporting the null hypothesis that there was no significant difference before the intervention.

**Hypothesis 2:** There is no significant difference in the performance of undergraduates taught using the WhatsApp Learning Platform and those taught using the Conventional Method in Biology.

**Table 5: t-test analysis of the difference in the performance of undergraduates taught using the WhatsApp Learning Platform and those taught using the Conventional Method in Biology**

Group	N	Mean	SD	Df	t	P
Whatsapp Learning Platform	108	75.60	7.20	198	6.56	0.0001
Conventional Method	92	68.50	8.10			

**p<0.05 (Significant).**

**Discussion**

The study revealed that undergraduates' performance in Biology improved under both the WhatsApp Learning Platform and the Conventional Method, with a markedly greater enhancement in the WhatsApp group, a result consistent with Adewale and Oladipo (2023) and corroborated by Bello et al. (2022), who found that WhatsApp's interactive and flexible nature enhances comprehension and retention, although Akinbo and Musa (2021) cautioned that unstructured mobile use may cause distractions. Both groups also developed more positive attitudes toward Biology, with a stronger shift in the WhatsApp cohort, in line with Ojo and Fadipe (2023) and in consonant with Eze and Nnamani (2022), who linked mobile-assisted learning to improved

motivation, though Onwuka (2021) warned of blurred academic-social boundaries. Baseline comparisons showed no significant differences in performance, consistent with Adeyemi (2022), indicating group equivalence before treatment. Post-intervention, the WhatsApp group outperformed the conventional group, in consonant with Akande and Adebola (2023), while Igbo and Danjuma (2021) suggested outcomes may vary with digital literacy. Though Abubakar (2022) noted possible social media fatigue. No significant gender interaction effects were found for performance, in consonant with Ogunyemi and Salami (2022) indicating that WhatsApp learning benefits students equitably. These findings suggest that integrating WhatsApp into Biology instruction can enhance learning

outcomes across genders, offering a cost-effective, inclusive strategy for resource-constrained contexts while highlighting the need for careful instructional design to mitigate potential distractions and overload.

The finding of the study showed that there was no significant interaction effect of the WhatsApp Learning Platform and gender on undergraduates' performance in Biology. This is consonant with the work of Ogunyemi and Salami (2022) who reported that when both male and female students have equitable access to digital learning tools, gender does not significantly influence academic outcomes. This suggests that the benefits of WhatsApp-assisted learning are equally accessible regardless of gender, possibly due to the platform's widespread familiarity and ease of use among students. However, some studies, such as Olajide (2020), have found that female students sometimes exhibit higher engagement levels in technology-mediated learning environments, which can lead to performance differences. The absence of a gender interaction effect in this study may be explained by the relatively uniform digital literacy and social context of the participants, minimizing gender-based disparities. The implication of this finding is that WhatsApp Learning Platforms can be promoted as inclusive tools in Biology education, supporting gender equity in STEM learning outcomes.

### Conclusion

The study concluded that the use of the WhatsApp Learning Platform (WLP) significantly enhanced undergraduates' performance in Biology compared to the Conventional Method. Both instructional approaches improved performance, but the WLP demonstrated greater effectiveness in promoting learning outcomes. The lack of significant interaction between the WLP and gender indicates that the platform's impact was consistent across male and female students. Hence, integrating WhatsApp as a learning tool will be an effective strategy for improving academic performance and student engagement in Biology education.

### Recommendations

Based on the findings of the study, the following recommendations were made: Lecturers should consider incorporating the WhatsApp Learning Platform as a supplementary tool in teaching Biology to enhance student engagement, performance. Universities should provide training for lecturers on the effective use of digital platforms like WhatsApp to improve instructional delivery and student learning outcomes. Students should be encouraged to actively participate in online learning platforms to maximize collaborative learning, knowledge sharing, and peer support.

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## IMPACT OF THE ACQUISITION OF DIGITAL SKILLS ON GRADUATES' EMPLOYABILITY IN TARABA STATE, NIGERIA

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### Abstract

This study examined the impact of the acquisition of digital skills on graduates' employability in Taraba State. Two research questions were raised and two hypotheses formulated in the study. Descriptive survey research design was adopted. Sample size of 200 graduates were used for the study. Two instruments namely, Graduates' employability Questionnaire (GEQ) and Digital Skills Acquisition Questionnaire (DSAQ) with overall index values of 0.88 were used for Data collection. The Data collected were analyzed using mean and standard deviation to answer the research questions while, t-test was used to test the null hypotheses at 0.05 level of significance. The result reveals that graduates who had high digital communication and competence skills had high impact of graduates' employability than those with low digital communication and competence skills. Based on the result it was recommended that Government, institutions and various stakeholders should prioritize digital skills acquisition among the learners as a means of livelihood, concerted effort should be made to promote digital competence among the learners amidst digital barriers.

**Key words:** Skills, digital skills acquisition, digital communication skills, digital competence skills, graduates' employability

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### Introduction

In the present digital economic world, digital skills have become a turning point for businesses and companies for efficiency and productivity thus, call for digital skills acquisition and competency among learners. Digital skills in the 21<sup>st</sup>-century labour market are in fact a basic necessity for employability. These skills which companies and business enterprises demand are modern indices of economic growth in the 21<sup>st</sup>-century world. These skills demand compel universities to integrate academic policies and

approaches with digital learning which inevitably increases individual opportunities of employability after graduation. Certainly, the employability of an individual by businesses and companies today, depends on technological skills one has acquired (Ekwue, Udemba & Ojuro, 2019). Thus, exalting pressure on different higher educational institutions and their stakeholders with the needs to prepare and equip students or undergraduates

with digital skills in addition to academic skills (Saad & Majid, 2014).

Conceptually, Digital skills refer to the abilities required to use digital technologies effectively for communication, information management, problem-solving, and productivity. It involves a broad range of proficiencies crucial for navigating the digital landscape, including the adept utilization of digital devices, software, and applications to not only accessing and managing information but also to communicate more effectively (Organization for Economic Co-operation and Development, 2016). In view of the above, Deloitte (2017) affirmed that digital skills (DS) are strongly correlated with employee's adaptability in the workplace. Adding that employees who possess digital literacy are better equipped to embrace technological changes and adapt to new tools and software, making them to remain effective in evolving work environments. However, this paper will focus on digital communication skills and digital competence skills.

Digital communication skills involve the use of emails, social media, and online collaboration tools for professional interaction. Empirical studies highlight their importance in employability of graduates. **Van Laar et al. (2017)** found that digital communication skills significantly predicted employability outcomes among graduates. **World Economic Forum (2020)** reported that employers increasingly demand graduates who can communicate effectively using digital platforms. **Dordevic (2025)** identified poor digital communication skills as a barrier to graduate employability in Nigeria. These findings imply that graduates in Taraba State who lack digital communication skills may struggle to meet employer expectations. As put forward by Erwin and Mohammed (2022), digital skills describe a person's capacity to effectively communicate information using various digital platforms and other forms of media to perform a task. Therefore, digital skills provide individuals and organizations with opportunities leveraging on tools to communicate and produce digital opportunities for solving their personal,

professional, organization and social life challenges (Gillian, Pritchard, & Hine, 2021). Acquisition of digital skills is the process through which individuals gain digital competencies through formal education, training programmes, self-learning, or practical experience. In this study, it refers to the way and manner graduates have learned and developed relevant digital competencies.

Digital competence entails the ability to work with cutting-edge technologies and digital information, familiarity with ICT ideals and understanding that users have the right to innovate, control, design, and realize their full potential in this space (Ferrari, 2013). The capacity for doing so is associated with cognitive-thinking techniques for using digital information and completing tasks in digital settings. Also, **Nwafor and Yomi (2020) in their study** observed that graduates who actively used online job portals and professional networking sites had higher employment rates. **OECD (2019)** reported that internet proficiency increases employability by enabling participation in remote work and digital labour markets. According to Uduafemhe, Ewim and Karfe (2023), digital skill proficiency extends beyond mere technical prowess to include competencies such as critically evaluating online information, adapting communication styles to various digital platforms, and safeguarding digital assets through cybersecurity awareness. It entails problem-solving abilities, enabling individuals to trace and correct technical faults identified and find innovative solutions using digital tools. Fonseca and Picoto (2020) emphasize the following as core competencies in the context of digitalization: evaluating data, information and digital content; browsing, searching, filtering data, information, and digital content; interacting through digital technologies; managing data, information and digital content; and collaborating through digital technologies. **Okoye, Adetimirin, and Ayo (2020)** reported that Nigerian graduates with competencies in word processing, spreadsheets, and presentation software were more employable than those without such skills competence. The term graduate is

referred to someone who have successfully completed a course of study or training, especially someone who has been awarded academic degree (Damian in Charles, 2020). It is someone who has received a degree or diploma on completing a course of study in University, polytechnic and College of education. Therefore, graduates' employability refers to the ability of graduates to obtain, maintain, and progress in employment. It includes employment status, readiness for work, job quality, and the capacity to adapt to changing labour-market demands.

Studies in Nigeria and beyond revealed that graduates with higher levels of digital competence tend to have better employability outcomes, including higher likelihood of gaining employment and increased job readiness in digital work environments. Nakibugwe et al (2024) conducted a study on the *Relationship between Digital Skills and Employability of Graduates from Makerere University and found that graduates with higher levels of digital competency were significantly more likely to secure employment* and had greater satisfaction in their roles. Furthermore, Joshua et al (2024) examined the *influence of digital skills acquisition on perceived employability prospects of accounting education students and found that students who reported higher mastery of digital skills believed they had better chances of being employed upon graduation*. Samuel et al (2025) examined the *impact of targeted digital skills training on graduate employability through 21st-century digital competence and found that an enhanced digital competence translated to greater job application confidence and workplace readiness*, indicating that targeted digital training can effectively improve employability prospects for unemployed and under-employed graduates.

#### Statement of the Problem

Despite growing evidence that digital skills boost employability, Taraba State still records high graduate unemployment and limited formal, scaled digital-skills programmes tailored to recent graduates. Local evaluations of skills-acquisition programmes in Taraba indicate low absorption of graduates into quality digital

jobs or digitally-enabled self-employment, suggesting a mismatch between available training and employer expectations (skills type, depth, and applied competence). This gap undermines the potential of digital-skills investments to reduce graduate unemployment in Taraba and motivates an empirical study that measures impact of the acquisition of digital skills on graduates' employability in Taraba State.

#### Purpose of the study

The purpose of this study is to examine the impact of the acquisition of digital skills on graduates' employability in Taraba State. Specifically, the study sought to;

1. Determine the impact of Digital communication skills on graduates' employability in Taraba State.
2. Determine the impact of Digital competence skills on graduates' employability in Taraba State.

Research Questions:

The study was guided by the following research questions:

1. What is the impact of Digital communication skills on the mean scores of graduates' employability in Taraba State?
2. What is the impact of Digital competence skills on the mean scores of graduates' employability in Taraba State?

#### Hypotheses

The following hypotheses guided the study:

Ho<sub>1</sub>: Digital communication skills **do not significantly influenced** graduates' employability in Taraba State.

Ho<sub>2</sub>: Digital competence skills **do not significantly influenced** graduates' employability in Taraba State.

#### Methodology

The study adopted a descriptive survey research design. Descriptive survey design focuses on people, the vital facts of people and their beliefs, opinion, attitudes, motivation and their behaviours, describing in a systematic manner and facts about a given population (Nworgu, 2015). The study was carried out in Taraba State, Nigeria. Taraba state is made of sixteen local governments and a development Area. It has federal, state and private schools. The population of the study

consisted of all unemployed graduates of Taraba State who graduated from 2020-2024. A sample of 200 residents of four major town of Taraba State- Wukari, Jalingo, Takum, and Bali who have graduated from 2020- 2024 in Federal University Wukari, Federal polytechnic Bali and College of education Zing were used for the study. The sample size was 200 graduates randomly selected using multi-stage sampling procedure. Two instruments were used for the data collection namely; Graduates' Employability Questionnaire (GEQ) which was made up of 13 items and Digital Skills Acquisition Questionnaire (DSAQ) which has clusters A and B namely; Digital communication skills and Digital competence skills respectively. Cluster A has 8 items while cluster B has 13

items. The instrument was vetted by three experts to ensure it measures what it intends to measure. The reliability indexes were determined using Cronbach Alpha where GEQ yielded 0.83 while DSAQ yielded overall coefficient of 0.88. Data were collected through direct administration and retrieval by the researcher with the help of four research assistance. Data collected were analyzed using mean, and standard deviation) to answer research questions while t-test was used to test the formulated hypotheses at 0.05 level of significance.

### Results

**Research Question One:** What is the impact of Digital communication skills on the mean scores of graduates' employability in Taraba State?

**Table 1: Mean analysis of the influence of Digital communication skills of graduates' employability in Taraba State.**

Motivation	N	Mean	Std. Deviation	df	t	Sig.
Low Comm. Skills	73	79.80	5.26	198	-3.905	.000
High Comm. Skills	127	83.70	7.19			

Table 1 shows that graduates who had low Digital communication skills had a mean impact score of ( $M = 79.80$ ,  $SD = 5.26$ ), while those who had high Digital communication skills had a mean impact score of ( $M = 83.70$ ,  $SD = 7.19$ ). This shows that graduates who had high Digital communication skills had a higher mean impact score than those who had low Digital communication skills. However, the standard deviations of 5.26 and 7.19 indicate that the individual impact scores of the graduates who had high Digital communication skills varied more from their group mean than those who had low Digital communication skills.

**Ho<sub>1</sub>:** Digital communication skills do not significantly have impact on

graduates' employability in Taraba State.

Table 1 reveals that there is a significant difference in the mean impact scores of graduates who had low Digital communication skills and those who had high Digital communication skills in favour of those who had high Digital communication skills,  $t(200) = -3.905$ ,  $p = .000$ . Thus, the null hypothesis is rejected, ( $p < .05$ ). This implies that Digital communication skills have impact on graduates' employability in Taraba State.

**Research Question Two:** What is the impact of Digital competence skills on the mean scores of graduates' employability in Taraba State?

**Table 2: Mean analysis of the impact of Digital competence skills on graduates' employability in Taraba State.**

Motivation	N	Mean	Std. Deviation	df	t	Sig.
High Competent	127	26.20	2.08	198	-3.565	.000
Low Competent	73	23.59	4.57			

Table 2 shows that graduates' who had low Digital competence skills had a mean impact score of ( $M = 23.59$ ,  $SD = 4.57$ ), while those who had high Digital competence skills had a mean impact score of ( $M = 26.20$ ,  $SD = 2.08$ ). This shows that graduates' who had high Digital competence skills had a higher mean impact score than those who had low Digital competence skills. Besides, the standard deviations of 4.57 and 2.08 indicate that the individual impact scores of the graduates' who had low Digital competence skills varied more from their group mean than those who had high Digital competence skills.

**Ho<sub>2</sub>:** Digital competence skills **do not significantly have** impact on graduates' employability in Taraba State.

Table 2 reveals that there is a significant difference in the mean impact scores of graduates' who had low Digital competence skills and those who had high Digital competence skills in favour of those who had high Digital competence skills,  $t(200) = -3.565$ ,  $p = .000$ . Thus, the null hypothesis is rejected, ( $p < .05$ ). This implies that Digital competence skills have impact on graduates' employability in Taraba State.

### Discussion of the findings

The findings of this study revealed that graduates who had high Digital communication skills had a higher mean impact score than those who had low Digital communication skills. This means that digital communication skills significantly have impact on graduates' employability in Taraba State. This finding is in agreement with **Van Laar et al. (2017)** who found that digital communication skills significantly predicted employability outcomes among graduates. In the same vein, **Dordevic (2025)** identified poor digital communication skills as a barrier to graduate employability in Nigeria. Meaning that graduates who have high digital communication skills are liable to be employed.

Furthermore, the study also shows that graduates' who had high Digital competence skills had a higher mean impact score than those who had low Digital competence skills. The result revealed significant difference in the

mean impact scores of graduates' who had low Digital competence skills and those who had high Digital competence skills in favour of those who had high Digital competence skills. This finding is in line with **Okoye, Adetimirin, and Ayo (2020)** who reported that Nigerian graduates with competencies in word processing, spreadsheets, and presentation software were more employable than those without such skills competence. Again, Nakibugwe et al (2024) conducted a study on the *Relationship between Digital Skills and Employability of Graduates from Makerere University* and found that graduates with higher levels of digital competency were **significantly more likely to secure employment** and had greater satisfaction in their roles. Joshua et al (2024) examined the *influence of digital skills acquisition on perceived employability prospects of accounting education students* and found that Students who reported higher mastery of digital skills believed they had better chances of being employed upon graduation.

### Conclusion

In view of the above findings it was deduced that digital communication skills and digital competence skills had positive impact on graduates' employability in Taraba State. In a specific term, graduates who had high digital communication skills had high impact of graduates' employability than those with low digital communication skills. In other way, graduates who had digital competence skills had high impact of graduates' employability than those with low digital competence skills.

### Recommendations

The following recommendations are reach based on the findings that;

1. Government, institutions and various stakeholders should prioritize digital skills acquisition among the learners as a means of livelihood.
2. Concerted effort should be made to promote digital competence among the learners amidst digital barriers.

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## INSTITUTIONAL POLICY AND SCIENCE EDUCATION STUDENTS' ATTITUDES TOWARD ENTREPRENEURSHIP SKILLS ACQUISITION FOR SOCIAL IMPACT IN EKITI STATE UNIVERSITY

BY

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### Abstract

*This study investigated the influence of Institutional Policy on Undergraduates' Attitudes toward Entrepreneurship Skills Acquisition in Ekiti State University (EKSU). The study specifically examined how the University's policy on Entrepreneurship Skills Acquisition could shape students' perceived value and their attitudes toward skills acquisition. It also identified the challenges that Science Education undergraduates face in acquiring entrepreneurship skills. It equally study policy improvements capable of enhancing skills acquisition among students for social impact thereby addressing Sustainable Development Goal (SDG 4). The study adopted descriptive research design of the survey type. The sample selected for the study was 100 respondents from the department of Science Education during 2023/2024 academic session. The instrument tagged Institutional Policy and Science Education Students' Attitudes toward Entrepreneurship Skills Acquisition for Social Impact in Ekiti State University Questionnaire with the reliability coefficient of 0.81 was used for the study. The data were analyzed using descriptive and inferential statistics. The study revealed that Institutional Policy including the integration of artificial intelligence among others into Entrepreneurship Skills Acquisition programme will positively influence students' attitudes towards skills acquisition. Findings also showed that the other challenges faced by students in acquiring entrepreneurship skills in Ekiti State University are overcrowded classroom and lack of collaboration for problem-solving in science-based skills acquisition among the others. It was recommended among the others that the University Management should come up with Institutional Policy strategies reform fostering students' attitudes towards Entrepreneurship Skills Acquisition.*

**Keywords:** Entrepreneurship Skills Acquisition, Institutional Policy, Challenges, Students' Attitudes, Social Impact.

## Introduction

Entrepreneurship is popularly recognized as a vital tool for economic growth and development and innovation, including employment generation across the globe. Universities, particularly in developing countries such as Nigeria, are now focusing on much more than theoretical learning and are now considering entrepreneurial ecosystems that are capable of nurturing innovative mind-sets targeting real-life problem solving. Particularly, the Science Education students who are potentially products and services providers in scientific solutions based on their exposure to scientific knowledge. This knowledge have equipped them with analytical and problem-solving skills to mention but few, which can be leveraged to develop innovations and research-based scientific solutions for entrepreneurial ventures creation. However, the translation of the knowledge into entrepreneurial action often depends on the policy environment of the university, which can either facilitate or inhibit skill acquisition and entrepreneurial engagement (Batista et al., (2024). Nigerian Universities has implemented ESA through entrepreneurship education programs as a matter of compulsion. The National Universities Commission (NUC) requires all universities to incorporate entrepreneurship courses into undergraduate curricula (National Universities Commission, (2018). Entrepreneurship Skills Acquisition (ESA) refers to the structured process through which students acquire the knowledge, skills, attitudes, and competencies necessary to identify, create, and manage business opportunities successfully (Akanbi, Akinbode, and Adebayo, (2020). In Nigerian Universities, ESA is aimed at fostering self-employment, encouraging innovation, and promoting economic development (Oyelaran-Oyeyinka and Adeoti, (2021). The skills typically acquired include financial management, marketing, business planning, leadership, problem-solving, communication, and technical skills relevant to specific

industries (Olatunji, Adebisi, and Ajayi, (2019). these are capable of enhancing the quality of university education and address the SDG 4: quality education. Acquisition of these skills are aimed at fostering services and products in scientific solutions for social impact.

Despite the concerted efforts by the Nigerian government and educational institutions to promote entrepreneurship through various initiatives, many students are not enthusiastic towards ESA. In Ekiti State University (EKSU), there is limited empirical evidence on how Institutional Policy structures on entrepreneurship education influence undergraduates' attitudes towards ESA. Without a clear understanding of students' challenges in skills acquisition, their attitudes and policy structures, the university may continuously struggle in the achievement of her vision statement on entrepreneurship 'to producing graduates adequately equipped to handle cotemporary socio-economic and environmental challenges through cutting edge research in science, technology and humanities, driven by information and communication technology". The Institutional Policy may not have been well aligned to fostering a favorable entrepreneurship attitudes among students. Asides, several factors, such as inadequate funding, lack of infrastructure, mentorship and counselling programs, overcrowded classroom, insufficient training, and weak support systems, may negatively influence the willingness of students and their ability to acquire entrepreneurship skills in spite of being well-positioned to drive innovation to address social needs.

Institutional policy on entrepreneurship could be referred to as the way and tradition in which institution run entrepreneurship education which include the classroom and outdoor activities in fostering entrepreneurship spirit and motivation among students. It may include entrepreneurship curricula and extracurricular activities, innovation laboratories, funding initiatives and other institutional supports. According to (Li,

(2024), Ying and Yaakob, (2025), effective policy must provide practical experiences, mentorship, and access to resources that build entrepreneurial self-efficacy. Institutional policy structures on entrepreneurship education targeting, infrastructure, mentorship initiatives, funding mechanisms, and cultural norms, plays a central role in shaping students' entrepreneurial attitudes (Wright, Stewart & Abernathy, (2025). Even though emphasizing theory and practices, the policy will be more vibrant by adequately attending to hands-on skills acquisition particularly in science-oriented entrepreneurship fostering projects on real-world problem-solving for social impact. Without the aforementioned, even highly capable science undergraduates may not be opportune to fully translate their technical knowledge into entrepreneurial ventures (Amaral, Nieuwenhuizen, & Schachtebeck, (2024)). Policy strategies that are not adequately developed may lack the ability to forestall various huddles in ESA. Therefore, besides the Institutional Policy practices on ESA, students' attitudes towards skills acquisition could also be shaped by the challenges they face in skills acquisition.

According to Huang, Cai and Yang (2021), institutional entrepreneurship policy including funding support, entrepreneurship services, and policy-driven opportunities strengthens students' attitudes towards entrepreneurship by enhancing their exposure to entrepreneurial practices and promoting an internal entrepreneurial spirit. Huang et al. reported that a supportive policy climate encourages students' entrepreneurial spirit like; motivation, confidence and proactive mindset which further enhances skill acquisition and attitudes towards entrepreneurship. Fan et al. (2024) assert that institutional entrepreneurship education policies which include course design, compulsory entrepreneurship modules and structured practical training shaped students' psychological determinants such as attitude. The

findings of Fan et al. showed that institutions with stronger entrepreneurship-supportive policies encapsulating practical laboratories, mentorship and competitions enhance higher students' engagement and skills development. Montes et al. (2023) assert that the effectiveness of entrepreneurship education determined by institutional structures and policies directly influences students' acquisition of knowledge, skills, and their attitudes towards entrepreneurship. Study conducted by Montes et al. showed that students exposed to more structured institutional programmes including competitions, incubation support and project-based learning demonstrated favourable attitudes towards entrepreneurship. The policy structures could either enhance students' mind-sets or lead to attitudinal barriers in skills acquisition.

Inadequacies of institutional policy structures may give room for different barriers in skills acquisition. According to Lufsten (2020), weak mentorship structures within Universities hinder students' development of entrepreneurial competencies and reduce their likelihood of entrepreneurial engagement. According to Haung et. al.(2021), a supportive policy climate encourages students' entrepreneurial spirit in relation to motivation, confidence and proactive mindset which further enhances skills acquisition. The absence of robust experiential learning opportunities, such as real-world projects, internships, and innovation laboratories, limits the practical skills development necessary for entrepreneurial success. Mukorera and Mwangi, (2022) emphasize that experiential learning is central to students' entrepreneurial capability building, particularly in African contexts where practical exposure is often limited. These challenges interconnected and may shape students' attitude for ESA. Sirelkhatim and Gangi (2015) argue that

gaps in funding, mentorship, and experiential learning are persistent systemic issues in entrepreneurship education globally while Al-Fattal, (2024) asserts that students' ability to acquire entrepreneurship skills is strongly constrained by structural, financial, and psychosocial factors within the university environment.

Moreover, in a study conducted by Al-Fattal, it was reported that students perceived insufficient institutional support, such as weak incubation services, limited access to start-up capital, lack of mentorship and entrepreneurial networks, fear of failure and low self-confidence as major barriers that hinder active participation in skill-building activities. Relatedly, Pham, Do and Nguyen, (2023) assert that acquiring digital and traditional entrepreneurship skills require adequate institutional digital resources, updated curricula, and hands-on training, which are often lacking. Pham et al. reported that lack of technology-driven training, insufficient digital laboratories and tools, and weak integration of digital entrepreneurship into the curriculum are part of challenges faced by students and that institutional supports especially technology-oriented facilities boost entrepreneurial self-efficacy, which in turn improves attitudes toward skill acquisition. According to Silveyra-Leyn, (2023), curricular design and cognitive readiness significantly influence students' ability to acquire entrepreneurship skills. Silveyra-Leyn reported that mismatch between curriculum content and real-world entrepreneurial demands, students' low entrepreneurial cognition which include creativity and opportunity recognition partly due to insufficient exposure to practical challenges and inadequate transition from classroom training to incubation and market environments weakens skill development.

Meanwhile, Onwubuya, (2024) posit that institutional capacity and policy shortcomings are major obstacles to effective entrepreneurship skills development in Nigerian universities. Onwubuya reported that students face

poor access to practical training such as workshops, tools, and incubators and that many universities lack qualified entrepreneurship educators, resulting in theory-heavy and practice-deficient delivery. The study also showed that funding constraints limit the ability of students to develop prototypes or participate in entrepreneurial projects while gender disparities and socio-cultural expectations create unequal access to opportunities and support services. Thus, Ogunlela and Enyekit, (2023) submit that addressing these challenges in Nigerian Universities is essential for strengthening entrepreneurial spirit among students.

Meanwhile, students' attitudes towards skills acquisition may simply be explained as the positive or negative evaluation of ESA expressed through their mind-sets, perception and grit to mention but few. Attitude towards entrepreneurship skills acquisition refers to an individual's evaluation of the skills acquisition as a desirable and feasible career path capable of predicting entrepreneurial intention ( Li (2024)). These may be influenced by feelings of the ease or difficulty of becoming entrepreneurs based on their self-efficacy, perceived feasibility, risk tolerance, and students' willingness to engage in venture creation (Aditya, (2020). Several studies have examined the influence of institutional policy on students' attitudes toward entrepreneurship. Li (2024) found that formal policies, including curriculum design and mentorship programs, significantly influence entrepreneurial self-efficacy and perceived behavioral control among fourth-year undergraduates in China. Similarly, Ying and Yaakob, (2025) reported that institutional support mediates the effect of entrepreneurship education on attitude, highlighting the importance of policy that is actionable rather than merely symbolic. In the Nigerian context, Adeoye and Olubiye (2024) reported that technical ability, parental background, and institutional support were significant predictors of attitudes towards entrepreneurship among final-year undergraduates. Their study highlighted that policy gaps such as lack of mentorship and limited funding constrain the positive influence of

institutional initiatives on students' attitudes. Science students may have high technical competence but may perceive entrepreneurship as risky or unsupported without strong institutional backing, which can limit skill acquisition and entrepreneurial engagement (Adeoye & Oluibi, (2024)).

Importantly too, other factors like age and gender may interact with policy structures and influence students' attitudes towards skills acquisition. Nwaordu, (2024) reported that strong institutional policy frameworks including funding mechanisms, compulsory skill-based courses, and teacher capacity development motivate students across age groups but are particularly impactful for older learners, who tend to align their entrepreneurial attitudes with perceived institutional seriousness and opportunity structures. Similarly, Adetayo and Oloruntoba, (2024) also reported that when Institutional Policy clearly outlines skill-based outcomes and ensures consistent delivery, students show significantly improved entrepreneurial attitudes regardless of age, though older students still show higher levels of intention. The study showed that gender both moderates and mediates the effect of entrepreneurship education on attitudes and skills acquisition. Females typically reported lower initial entrepreneurial self-efficacy and higher perceived risk. Studies also showed high interest across genders but different enabling factors such as networks/relational support, university ecosystem and social norms to mention but few (Tsaknis et al., 2025) & Adelowo & Akinwale, (2023)).

Interestingly, the social impact of institutional arrangements and students' attitudes on skills acquisition are multi-layered. At the individual level, graduates acquire capacities for self-employment, income generation, and resilience in contexts of unstable labour markets (Olu-Alonge, (2025)). At the community level, student-led innovations often target locally specific challenges such as water purification, agricultural processing, renewable energy solutions, and health-

related technologies thereby contributing to improved welfare, environmental sustainability, and local economic diversification (Adekunle et al., (2025) and Abraham, (2024)). At the macro level, Universities operating under robust entrepreneurship-supportive policy structures contribute to regional innovation ecosystems by stimulating start-up creation, fostering academic-industry linkages, and supporting value-chain development in science-related sectors (Ofor-Douglas, (2024)). Institutional supports fostering students' attitudes on skills potentially enhance the achievement of Sustainable Development Goal (SDG) 4. According to United Nations. UN, (2024a), Sustainable Development Goal 4: Quality Education aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". This means not just getting children into school but making sure the education they receive is high quality, inclusive, equitable, and empowers learners with relevant knowledge and skills throughout life. The SDG 4 includes several specific targets that countries work towards achieving by 2030 for instance; increased youth and adult skills for employment and decent work, and equal access to affordable technical, vocational and tertiary education (including universities). In furtherance, quality education is widely recognized as a foundation for individual and societal development which breaks cycles of poverty by enhancing knowledge and earning potential, reduces inequalities and promotes social inclusion and also builds skills essential for sustainable livelihoods, economic productivity, health, and civic engagement, contributing to the achievement of other SDGs.

### **Statement of the Problem**

In spite of the various laudable initiatives by the Nigerian government and educational institutions to enhance employability and self-reliance through various policy structures fostering entrepreneurship education, there exist conspicuous display of indifferent attitudes among students towards entrepreneurship skills acquisition in Ekiti State University. The policy

structures guiding the content and delivery of the skills acquisition programme may not have been adequate enough to enhance students' attitudes, particularly in science education for skills acquisition. Several factors, such as inadequate funding, lack of infrastructure, mentorship and counselling programs, insufficient training, and weak support systems, may not arouse students' interests and thus, inhibiting their attitudes towards entrepreneurship skills acquisition. Non prioritizing support services such as provision of incubation centers, loans and grants, organizing workshops and seminars or guest lectures and counselling to guide students' in entrepreneurship skills acquisition may have unfavorable influence on students' attitudes in respect of skills acquisition. Policy structures that do not cater for funding, collaborative problem-solving skills acquisition, trainers-students ratio, University-Industry collaboration and creating lecture free day(s) to allow students' adequate participation in skills acquisition, entrepreneurship fare, exhibition, drama and other extra curricula activities may find it difficult to enhance students' attitudes towards skills acquisition.

### Research Objectives

The objectives of this study are to:

1. examine the influence of institutional policy on students' attitudes towards entrepreneurship skills acquisition.
2. find out the extent to which institutional support services influence students' interest in entrepreneurship.
3. identify the challenges faced by Science Education undergraduates in acquiring entrepreneurial skills.
4. propose policy improvements that can enhance entrepreneurship skills acquisition and social impact among students

### Research Questions

This study was guided by the following research questions:

1. How could institutional policy influence students' attitudes towards entrepreneurship skill acquisition?
2. To what extent could institutional support services influence students' interests in entrepreneurship skills acquisition?
3. What are the challenges students face in acquiring entrepreneurship skills?
4. What policy improvements can be made to enhance entrepreneurship skills acquisition among students for social impact?

### Research Hypotheses

The following research hypotheses were formulated:

1. There is no significant difference in the attitudes towards entrepreneurship skills acquisition between male and female undergraduates.
2. There is no significant relationship in the undergraduate's age and their attitudes towards entrepreneurship skills acquisition.
3. There is no significant difference in the undergraduates attitudes towards entrepreneurship skills acquisition at different academic levels

### Methodology

This study adopted a descriptive research design of the survey type to examine the influence of Institutional Policy on entrepreneurship education on Science Education undergraduates' attitudes towards skills acquisition. The target population comprised of all undergraduate students in the department of Science Education in Ekiti State University, Ado-Ekiti, Nigeria during 2023/2024 academic session, who were currently enrolled in entrepreneurship education programs or have completed the programme as part of their curriculum. The sample size for the study was 100 students. A structured questionnaire titled Institutional Policy and Science Education Students' Attitudes toward Entrepreneurship Skills Acquisition for Social Impact in Ekiti State University Questionnaire with the reliability coefficient of 0.81 was used for the study to collect data. Data collected was

analyzed using descriptive statistics (mean, frequency, and percentage) for the research questions while the hypotheses were tested at 0.05 level of significance.

## Results

### Descriptive Analysis

**Table 1: Socio-demographic Characteristics of the Study Participants**

Variable	Grouping	Frequency	Percentage
Gender	Male	49	49.0
	Female	51	51.0
Age	Under 20	23	23.0
	21-25yrs	54	54.0
	26-30yrs	22	22.0
	Above 30	1	1.0
Level	100l	28	28.0
	200l	26	26.0
	300l	14	14.0
	400l	32	32.0

Table 1 presents the socio-demographic characteristics of the respondents. The result shows that 49% of the study participants were male while 51%; representing the majority constituted the female sample. Distribution of the respondents according to age reveals that 23% were under 20years, 54% respondents; representing the majority were within 21-25years age range, 22% were aged 26-30years while 1% was above 30 years. Regarding the

respondents' academic level, less than one-third of the study participants (32%) were 400 level students, 28% indicated 100 level while 26% and 14% represented 200 level and 300 level respectively.

**Question 1:** How could Institutional Policy on entrepreneurship influence students' attitudes towards entrepreneurship skills acquisition?

**Table 2: Descriptive statistics on the Influence of Institutional Policy on Students' Attitudes towards Entrepreneurship Skill Acquisition**

S/N	ITEMS	SA	A	D	SD	MEAN
1	Friendly institutional policy will enhance my dedication in entrepreneurship skill acquisition.	75 (75.0)	22 (22.0)	2 (2.0)	1 (1.0)	3.71
2	Integration of advance technology such as Artificial intelligence will enhance my passive value and interest in entrepreneurship skills acquisition	36 (36.0)	61 (61.0)	3 (3.0)		3.33
3	Introduction of online and international marketing skills into skill acquisition will arouse my interest	34 (34.0)	49 (49.0)	16 (16.0)	1 (1.0)	3.16
4	The institutional policy structures are not clear to me regarding entrepreneurship skill acquisition	26 (26.0)	55 (55.0)	17 (17.0)	2 (2.0)	3.05
5	I am not satisfied with the operational policy on entrepreneurship in the University	28 (28.0)	50 (50.0)	14 (14.0)	8 (8.0)	2.98

**Criterion mean= 2.50**

Table 2 presents the influence of Institutional Policy on students' attitudes towards entrepreneurship skills acquisition. The result shows that using a cut-off mean score of 2.50 for the

rating scale, all the items had mean scores above the cut-off point. This implies that; Institutional Policy including the integration of artificial intelligence, introduction of online and international

marketing skills among others into Entrepreneurship Skills Acquisition programme will positively influence students' attitudes towards the skills acquisition

**Question 2:** To what extent do institutional support services affect students' interests in entrepreneurship?

**Table 3:** Descriptive Statistic on the Influence of Institutional Support Initiatives on Students' Interest In Entrepreneurship Skill Acquisition

S/N	ITEMS	SA	A	D	SD	MEAN
11	Availability of incubation centers in the University will arouse my interest in entrepreneurship.	54 (54.0)	38 (38.0)	7 (7.0)	1 (1.0)	3.45
12	There are no loans and grants to support my vision and enhance my interest in entrepreneurial skills and start up	46 (46.0)	41 (41.0)	9 (9.0)	4 (4.0)	3.29
13	Workshops, seminars, or guest lectures are not provided by the university to inspire my interest in entrepreneurship	45 (45.0)	31 (31.0)	19 (19.0)	5 (5.0)	3.16
14	The University does not provide entrepreneurship counsellor to guild my interest in entrepreneurial skills	26 (26.0)	57 (57.0)	12 (12.0)	5 (5.0)	3.04
15	Institutional support services are not tailored to address the specific needs of students interested in entrepreneurship	30 (30.0)	43 (43.0)	17 (17.0)	10 (10.0)	2.93

**Criterion mean= 2.50**

Table 3 presents the influence of institutional support services on students' interest in entrepreneurship. The result shows that, using a cut-off mean score of 2.50 for the rating scale, all the items had mean scores above the cut-off point. This implies that the effect of institutional

support services on students' interest in entrepreneurship is positive.

**Question 3:** What are the challenges faced by students in acquiring entrepreneurship skills?

**Table 4:** Descriptive Statistics on Challenges Faced by Students in Acquiring Entrepreneurship Skills

S/N		SA	A	D	SD	MEAN
6	Overcrowded classroom is one of the main challenges in accessing entrepreneurship training	77 (77.0)	21 (21.0)	2 (2.0)		3.75
7	There is no collaboration for problem-solving in science based skills acquisition	46 (46.0)	43 (43.0)	10 (10.0)	1 (1.0)	3.34
8	There are no adequate man power to operate facilities and resources provided by the university.	60 (60.0)	30 (30.0)	9 (9.0)	1 (1.0)	3.49
9	Academic workload and schedules affect my ability to pursue entrepreneurship skills	27 (27.0)	52 (52.0)	17 (17.0)	4 (4.0)	3.02
10	There is no mentorship opportunities to facilitate entrepreneurship skill acquisition	41 (41.0)	36 (36.0)	21 (21.0)	2 (2.0)	3.16

**Criterion mean= 2.50**

Table 4 presents the challenges students face in acquiring entrepreneurship skills.

The result shows that, using a cut-off mean score of 2.50 for the rating scale,

all the items had mean scores above the cut-off point. This implies that overcrowded classrooms, lack of collaboration for problem-solving in science-based skills acquisition, inadequate man power to operate facilities and resources, academic workload and schedules as well as lack of mentorship

opportunities are the challenges faced by students in acquiring entrepreneurship skills.

**Question 4:** What policy improvements can be made to enhance entrepreneurship skills acquisition among students foe social impact?

**Table 5:** Descriptive Statistics on Policy Improvements to Enhance Entrepreneurship Skills Acquisition among Students for Social Impact

S/N	ITEMS	SA	A	D	SD	MEAN
16	There is need for policy improvement in entrepreneurship skills acquisition in the university to enhance social impact.	72 (72.0)	21 (21.0)	4 (4.0)	3 (3.0)	3.62
17	Funding towards entrepreneurship programs should be prioritized to enhance students' participation in socio-economic development,	57 (57.0)	40 (40.0)	3 (3.0)		3.54
18	The university should support collaboration and problem-solving in science-based skills acquisition among students to promote scientific solutions.	68 (68.0)	25 (25.0)	4 (4.0)	3 (3.0)	3.58
19	University/Industry collaboration to train students for local and regional economic development should be included in the Institutional Policy	58 (58.0)	34 (34.0)	7 (7.0)	1 (1.0)	3.49
20	The university should create lecture free day(s) to allow full participation in entrepreneurship skills acquisition and impacting the local community.	55 (55.0)	36 (36.0)	4 (4.0)	5 (5.0)	3.41

Criterion mean= 2.50

Table 5 presents the policy improvements that can be made to enhance entrepreneurship skills acquisition among students for social impact. The result shows that, using a cut-off mean score of 2.50 for the rating scale, all the items had mean scores above the cut-off point. This implies that increased funding towards entrepreneurship programs, adoption of collaboration and problem-solving in science-based skills acquisition among students, University/Industry collaboration to train students for local and regional economic growth, and creating lecture free day(s) to allow full participation in entrepreneurship skills

acquisition capable of impacting the local community, are areas of policy improvements that can be made to enhance skills acquisition among students for social impact.

**Testing of Hypotheses**

The research hypotheses formulated in the study were tested using Pearson's Product moment correlation and multiple regression statistics.

**Hypothesis 1:** There is no significant difference in the attitudes towards entrepreneurship skills acquisition between male and female undergraduates.

**Table 6:** t-test analysis on students' Attitude towards Entrepreneurship Skills Acquisition by considering their Gender

Gender	N	Mean	SD	df	t	p
Male	49	66.90	6.18	98	0.620	0.537
Female	51	66.12	6.40			

p>0.05

The result in Table 6 shows that computed t-value (0.620) with degree of freedom 98 was not statistically significant at  $p > 0.05$  level of significance for the groups. The null hypothesis was not rejected. This implies that there is no significant difference in the attitudes towards entrepreneurship skills acquisition between male and female undergraduates.

**Hypothesis 2:** There is no significant difference in the undergraduates age and their attitudes towards entrepreneurship skills acquisition.

**Table 7:** ANOVA summary on the Age of Undergraduates and their Attitudes towards Entrepreneurship Skills Acquisition

Source	SS
Between Groups	172.510
Within Groups	3722.490
Total	3895.000

$p > 0.05$

The result in Table 7 indicates that the computed F-value (1.483) obtained at 3 and 96 degrees of freedom for the groups with a p-value  $> 0.05$  was not significant at 0.05 level. The null hypothesis was not rejected; implying that there is no significant relationship between the age of undergraduates and their attitudes towards entrepreneurship skills acquisition.

**Hypothesis 3:** There is no significant difference in the undergraduate's attitudes toward entrepreneurship skills acquisition at different academic levels (100-400)

**Table 8:** ANOVA Summary of Undergraduates' Attitudes towards Entrepreneurship Skills Acquisition by Academic Levels

Source	SS	df	MS	F	p
Between Groups	94.809	3	31.603	0.798	0.498
Within Groups	3800.191	96	39.585		
Total	3895.000	99			

$p > 0.05$

Table 8 shows that the computed F-value (0.798) obtained at 3 and 96 degrees of freedom for the groups with a p-value  $> 0.05$  was not significant at 0.05 level. The null hypothesis was not rejected. This implies that there is no significant difference in the attitudes towards entrepreneurship skills acquisition between undergraduates at different academic levels (100-400).

## Discussion

The study showed that; Institutional Policy including the integration of advance technology such as artificial intelligence as well as the introduction of online and international marketing skills into Entrepreneurship Skills Acquisition programme will positively influence students' attitudes towards the MS skills acquisition. The finding aligns with the study of Ahmed and Musa, (2022) which asserted that Institutional Support plays a crucial role in shaping students' entrepreneurial attitudes. The study as well conform to the work of Oloruntoba, Oludipe, and Adetayo, (2024) which reported that proper delivery of entrepreneurship education degree programme was a strong factor that enhanced attitude and motivation of students towards entrepreneurship. The findings of the study also showed that institutional support services such as provision of incubation centers, loans and grants, organizing workshops, seminars or guest lectures, and counselling to guide students' in entrepreneurship skills acquisition would have positive influence on students' interests in entrepreneurship which is in agreement with the assertion of Cai, and Yang, (2021) that policy measures such as support, funding and start-up services indirectly shape students' attitudes by enabling practical experience and role model. The finding also align

with the study of Eze, and Obiora,

(2021) which asserted that strong and well-coordinated policies that prioritize funding, curriculum development, and the provision of practical learning opportunities directly contribute to the effectiveness of entrepreneurship programs..

The study also showed that overcrowded classrooms, lack of collaboration for problem-solving in science-based skills acquisition, inadequate man power to operate facilities and resources, academic workloads and schedules, and lack of mentorship opportunities are the challenges faced by students in acquiring entrepreneurship skills. This finding is in agreement with the study of Amadi, (2019) which revealed that challenges like insufficient funding, lack of training facilities, and inconsistent policy application hinder effective implementation of entrepreneurship programme. The finding also agrees with the report of Onwubuya, (2024) that students face poor access to practical training such as workshops, tools, and incubators and that many universities lack qualified entrepreneurship educators, resulting in theory-heavy and practice-deficient delivery. Findings as well revealed that increased funding towards entrepreneurship programs, adoption of collaboration and problem-solving in science-based skills acquisition among students, collaboration with external organizations to provide entrepreneurship training opportunities, and creating lecture free day(s) to allow full participation in skills acquisition are areas of policy improvements that can be made to enhance students' attitudes towards entrepreneurship skills acquisition. The findings agree with the assertion of Fan, Li, Chen, and Zhang, (2024) that institutional entrepreneurship education policies such as course design, compulsory entrepreneurship modules and structured practical training shape students' entrepreneurial attitudes. Similarly, the result is at par with the work of Wardana, et al. (2020) which reported that students' entrepreneurial mindset was influenced by the quality and structure of institutional programs such as emphasizing experiential learning and strengthening their willingness to acquire entrepreneurship skills.

The study revealed that there was no significant difference in the attitudes towards entrepreneurship skills acquisition between male and female undergraduates which is in contrast to the finding of Adelowo and Akinwale, (2023) which reported 12,485 Nigerian undergraduates' entrepreneurial interests across genders as 88% males and 84% females, also relational support and ecosystem effects varied by gender. Meanwhile, Tsaknis, Sahinidis, Kiriakidis, and Kavoura, (2025) reported that female students showed higher positive changes in entrepreneurial intention after exposure to an entrepreneurship programme, and asserted that gender moderates students' psychological response to entrepreneurship education. It was shown in the study that there was no significant relationship between the age of undergraduates and their attitudes towards entrepreneurship skills acquisition. The finding agrees with the study of Ahmad, (2024) which reported that demographic factors and behavioural traits shape students' entrepreneurial attitude but age did not have a significant effect on the students' attitudes. Whereas, Shahzad, and Xu, (2023) reported that age played a background role in entrepreneurial attitude among university students, which was shown in younger students responsiveness to entrepreneurship programs. The study further showed that there was no significant difference in the attitudes towards entrepreneurship skills acquisition between undergraduates at different academic levels. The finding supports the work of Oloruntoba, Oludipe, and Adetayo. (2024) which reported that there was no significant difference in the attitudes towards entrepreneurship skills acquisition between undergraduates at different academic levels. Whereas, Ying and Yaakob (2025) reported a study on vocational higher education institutions students' entrepreneurial attitude and asserted that academic level matters because the context influences how education converts to attitude.

### **Conclusion**

Based on the findings of the study, it was concluded that Institutional Policy significantly influences science

undergraduates' attitudes towards Entrepreneurship Skills Acquisition in Ekiti State University resulting in structural and resource barriers, suggesting the need for comprehensive policy reforms that integrate curriculum, infrastructure, mentorship, and funding mechanisms, potentially enhancing social impact and also aligning with SDG 4: (Quality Education)

### Recommendations

Based on the findings of the study, it was recommended that the University Management should;

1. come up with policy structures reforms fostering students' attitudes towards entrepreneurship skills acquisition.
2. initiate supports services such as provision of incubation centers, loans and grants, organizing workshops and seminars or guest lectures and counselling to guide students' in entrepreneurship skills acquisition
3. address the challenges faced by students such as; overcrowded classrooms, lack of collaboration for problem-solving in science-based skills acquisition, inadequate man power to operate facilities and resources, academic workloads and schedules, and lack of mentorship opportunities in acquiring entrepreneurship skills,
4. ensure policy improvements on; funding, collaborative problem-solving skills acquisition, trainers-students ratio, University-Industry collaboration and creating lecture free day(s) to allow students' adequate participation in skills acquisition, as well as entrepreneurship fare, exhibition, drama and other extra curricula activities to enhance students' attitudes towards Entrepreneurship Skills Acquisition.

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## EFFECTS OF ACTIVITY-BASED AND THINK-PAIR-SHARE INSTRUCTIONAL STRATEGIES ON SENIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN MATHEMATICS IN EKITI STATE, NIGERIA

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### Abstract

The study specifically investigated the effects of activity-based and think-pair-share instructional strategies on students' performance and attitude towards Mathematics. The study further investigated which of the strategies would be more effective. The study used gender and school-location as control variables. The study adopted quasi-experimental research design type. The population for the study comprised SSS II students across the state. The sample for the study consisted of 232 students. The instruments used for the study were Mathematics Performance Test and Students' Attitudinal Questionnaire with the reliability coefficients of 0.82 and 0.80 respectively. The two research questions raised were answered using mean and standard-deviation while the eight hypotheses generated were tested using ANOVA. The findings of the study showed that there were significant differences in performance mean score as well as the attitudinal mean score of students after treatments. The findings also showed that think-pair-share instructional strategy was more effective and that gender and school-location had no effect on students' performance and attitude towards Mathematics. It was concluded that both strategies were effective for the teaching of Mathematics. It was therefore recommended that mathematics teachers should adopt ABIS and TPSIS to teach by allowing students to participate actively in the class.

**Keywords:** Activity-Based, Think-Pair-Share, learning-outcomes

### Introduction:

Mathematics is a science of number, quantity and space. It is the science that deals with the system of counting, measuring and description of shapes and structures. Application of Mathematics in Biology, Chemistry, Physics, among others cannot be over-emphasized. Despite the importance attached to Mathematics, the students' performance and attitude towards the subject were not encouraging due to teaching method. The reports from WAEC statistical data on candidates' performance in Mathematics in the previous years; the outcome of the analysis of Ekiti State Ministry of Education on students' performance in Mathematics in external examinations in the previous years and the researcher's personal observations being a mathematics teacher in public secondary school in Ekiti State, revealed that students developed negative attitude towards mathematics and that failure

characterized their performance in the subject in both internal and external examinations. These observations gave this study an insight to investigate if the strategies would have possible effects on the students' performance and attitude towards Mathematics in both urban and rural schools in the state.

### Literature Review

Mathematics had been a relevant subject even from the ages past. Mathematics was incorporated during the conduct of census before the amalgamation of regions that was unanimously named Nigeria. Mathematics is a tool for making numerical interpretation and logical explanation of information, idea and situational issues using terms, rules, formulae, signs and symbols. Upon the relevancies of mathematics, students still consider the subjects so difficult to pass with good grade and therefore exhibited

care-free attitude towards the subject. Performance is the quantitative measure of the extent to which the purpose of teaching mathematics are accomplished. Iji (2010) described performance as the outcome of teaching while attitude is referred to as the state of mind of students towards learning which may be positive or negative (incivility behaviours in class). Teaching method is one of the problems that constituted students' poor performance as well as their negative attitude towards mathematics. Scholars had made researches into the issue of teaching method. Learning by doing/hand-on-activity is the main focus of activity-based and think-pair-share instructional strategies based on a Chinese proverb: "If you tell me, I may forget, If you show me, I may remember, If you involve me, I will understand." Abott, (2012) advocated for problem-solving and activity-based strategies due to learners' recurring failure in mathematics. Similarly, Azuka (2013) and Andrew (2014), activity-based learning strategy was the best for the teaching of mathematics. Ajiro (2017) specifically investigated the effects of practical approach on senior secondary school students' interest and performance in solid geometry and It was hence recommended in the study that mathematics teachers should adopt practically related teaching approach to teach the subject in the class.

Other factors that caused the problems of poor performance and negative attitude in mathematics class as traced in this study were students' gender and school-location. Bichi (2012) investigated gender influence on students' performance and therefore described genders as attributes which differentiate masculine from feminine, the amount of masculinity and femininity traits found in human beings. School-location is referred to in this study as the particular place where teaching and learning processes are being undertaken in the physical space. Essien (2017) recommended that government should brace up to bridge every gap between schools in the rural and urban areas to avoid biasness in terms of academic performance and also embark on adequate and unbiased

staffing of qualified teachers into the geographical areas, this was just for equity in students' academic performance as well as their attitude towards learning. This study therefore wished to consider activity-based and think-pair-share instructional strategies as approachable teaching strategies that could be capable of enhancing students' preferable performance and positive attitude towards mathematics by shifting focus on students' active participation in mathematics class.

### Methodology

This study adopted pre-test, post-test control group quasi-experimental research design type. Pre-test was used to ascertain the homogeneity of both groups, while post-test was used to measure the effects of the strategies. The experimental groups were exposed to treatments while, the control group was left to the use of conventional method. The population for this study comprised 12,58 SSSII students in 206 public secondary schools in Ekiti State while the sample for the study consisted of 232 SSS II students in two Local Government Areas selected from the sixteen Local Government Areas in Ekiti State using multistage sampling procedure. The experimental procedure for the study was in three different stages; (pre-treatment, stage, treatment stage and post-treatment stage) and last for eight weeks. The two instruments used for the study (Mathematics Performance Test and Student Attitudinal Questionnaire in Mathematics) were subjected to face, content and construct validities. The reliability co-efficient of 0.8280 was generated for Mathematics Performance Test (MPT) using test and re-test method and Parson Product Moment Correlation analysis while 0.80 was generated for the Student Attitudinal Questionnaire in Mathematics (SAQ) using Cronbach alpha formular. The main purpose of the study was to investigate the effects of the strategies on students' performance and their attitude towards mathematics. The study specifically investigated if school location would have effects on students' performance and attitude towards mathematics using activity-based and think-pair-share instructional strategies.

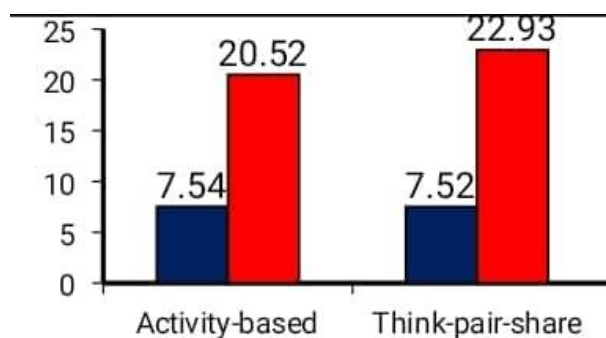
The two research questions raised were answered descriptively using mean and standard deviation while the eight hypotheses generated were tested using inferential statistics. Analysis of Variance. Scheffe Post hoc analysis was used to locate the source of pairwise difference.

### Results

**Table 1: Mean Scores of Students Before and After Treatments Performance Mean Scores of Students Before and After Treatments in Mathematics**

Teaching Method	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Activity-Based	94	7.54	2.93	20.52	4.21	12.98
Think-Pair-Share	58	7.52	2.74	22.93	4.05	15.41
Control	80	7.68	3.21	10.51	2.86	2.83
Total	232	7.58	2.92	17.67	6.48	

Table 1 implied that there was wide disparity in the performance mean scores of students in the experimental and control groups after treatments in Mathematics with differences of (12.98 - 2.83=10.15) and (15.41-2.83=12.58) respective. This was further depicted in Figure 1



### Descriptive Analysis

**Question 1:** What is the difference in the performance of students in the experimental and control groups before and after treatments in Mathematics?

**Figure 1:** Performance Mean Scores of Students Before and After Treatments in Mathematics

**Question 2:** What is the difference in the attitude of students in the experimental and control groups before and after treatments in Mathematics?

**Table 2: Attitudinal Mean Scores of Students Before and After Treatments in Mathematics**

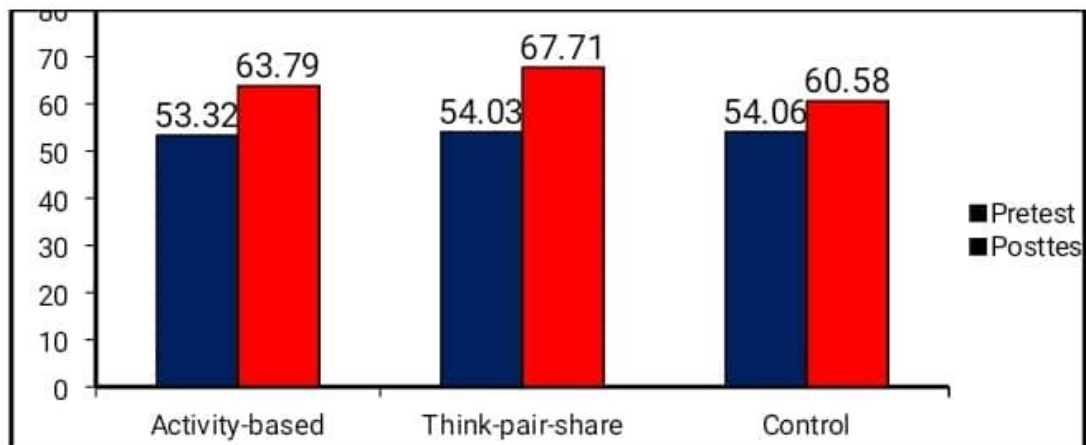
Teaching Method	N	Pretest		Posttest		Mean Difference
		Mean	SD	Mean	SD	
Activity-Based	94	53.32	8.03	63.79	8.73	10.47
Think-Pair-Share	58	54.03	7.76	67.71	8.87	13.68
Control	80	54.06	8.78	60.58	10.23	6.52
Total	232	53.75	8.20	63.66	9.66	

Table 2 showed that there was wide disparity in the attitudinal mean scores

of students in the experimental and control groups after treatments in

Mathematics with differences of  $(10.47 - 6.52=3.95)$  and  $(13.68-6.52=7.16)$  respective..

This was further depicted in Figure 2.



**Figure 2:** Attitudinal Mean Scores of Students Before and After Treatments in Mathematics

**Testing of Hypotheses**

**Hypothesis 1:** There is no significant difference in the performance mean scores of students in the experimental and control groups before treatments in Mathematics.

**Table 3:** ANOVA of Students’ Performance in Mathematics Before Treatments

Source	SS	Df	MS	F	P
Between Groups	1.081	2	0.541	0.061	0.941
Within Groups	2039.363	229	8.906		
Total	2040.444	231			

$P>0.05$

Table 3 indicated that both experimental and control groups were homogenous prior to treatments in terms of their performance in Mathematics with 0.941.

**Hypothesis 2:** There is no significant difference in the attitudinal mean scores of students in the experimental and control groups before treatments in Mathematics.

**Table 4:** ANOVA of Students’ Attitude towards Mathematics before Treatments

Source	SS	Df	MS	F	P
Between Groups	29.952	2	14.976	0.221	0.802
Within Groups	15519.044	229	67.769		
Total	15548.996	231			

$P>0.05$

Table 4 indicated that both experimental and control groups were homogenous

prior to treatments in terms of their attitude towards Mathematics with 0.802.

**Hypothesis 3:** There is no significant difference in the performance mean scores of students exposed to activity-

based and think-pair-share instructional strategies and conventional method in Mathematics.

**Table 5: ANOVA of Students' Performance in Mathematics After Treatments**

Source	SS	Df	MS	F	P
Between Groups	6467.934	2	3233.967	229.198	0.000*
Within Groups	3231.169	229	14.110		
Total	9699.103	231			

**P<0.05**

The result on Table 5 showed students exposed to activity-based and think-pair-share instructional strategies performed significantly better than the students exposed to conventional method in Mathematics with 0.000\*.

In order to locate the sources of pairwise significant difference among the groups, Scheffe Post-Hoc Test was carried out as depicted in Table 6.

**Table 6: Scheffe Post-Hoc Analysis of Students' Performance After Treatments in Mathematics**

Group	1	2	3	N	Mean
Activity-Based (1)		*	*	94	20.52
Think-Pair-Share (2)			*	58	22.93
Control (3)				80	10.51

**P<0.05**

Table 6 showed that there was significant difference in the performance mean scores of students exposed to activity-based and think-pair share instructional strategies at 0.05 level of significant.

**Hypothesis 4:** There is no significant difference in the attitudinal mean scores of students exposed to activity-based and think-pair-share instructional strategies and conventional method in Mathematics.

**Table 7: ANOVA of Students' Attitude towards Mathematics after Treatments**

Source	SS	Df	MS	F	P
Between Groups	1712.787	2	856.394	9.884	0.000*
Within Groups	19841.312	229	86.643		
Total	21554.099	231			

**P<0.05**

Table 7 indicated that students exposed to activity-based and think-pair-share instructional strategies had a better change in their attitude towards Mathematics than students exposed to conventional method with 0.000\* .

In order to locate the sources of pairwise significant difference among the groups, Scheffe Post-Hoc Test was carried out as depicted in Table 8.

**Table 8: Scheffe Post-Hoc Analysis of Students' Attitude After Treatments in Mathematics**

Groups	1	2	3	N	Mean
Activity-Based (1)		*		94	63.79
Think-Pair-Share (2)			*	58	67.71
Control (3)				80	60.58

**P<0.05**

Table 8 there was no significant difference between attitudinal mean scores of students in the activity-based and conventional methods at 0.05 level of significance.

**Hypothesis 5:** There is no significant difference in the performance mean scores of students exposed to activity-based and think-pair-share instructional strategies and conventional method in urban and rural schools in Mathematics.

**Table 9: 2 X 2 ANOVA of Students' Performance in the Experimental Groups and Control Group After Treatments in Mathematics Based on School Location**

Source	SS	Df	MS	F	P
Corrected Model	215.923	3	71.974	4.136	0.008
Location	1.181	1	1.181	0.068	0.795
Group	210.078	1	210.078	12.072	0.001
Location * Group	4.774	1	4.774	0.274	0.601
Error	2575.544	148	17.402		
Total	72667.000	152			
Corrected Total	2791.467	151			

**P>0.05**

Table 9 showed that school location had no effects on students' performance in Mathematics using activity-based and think-pair-share instructional strategies.

of students exposed to activity-based and think-pair-share instructional strategies and conventional method in urban and rural schools in Mathematics.

**Hypothesis 6:** There is no significant difference in the attitudinal mean scores

**Table 10: 2 X 2 ANOVA of Students' Attitude Mathematics in the Experimental Groups After Treatments Based on School Location**

Source	SS	Df	MS	F	P
Corrected Model	1119.300	3	373.100	5.018	0.002
Location	458.533	1	458.533	6.167	0.014
Group	518.648	1	518.648	6.976	0.009
Location * Group	22.448	1	22.448	0.302	0.584
Error	11003.536	148	74.348		
Total	659925.000	152			
Corrected Total	12122.836	151			

**P>0.05**

Table 10 indicated that school location had no effects on students' attitude towards Mathematics using activity-based and think-pair-share instructional strategies.

**Hypothesis 7:** There is no interaction effects of treatments, gender and school location on students' performance in Mathematics.

**Table 11: 3 X 2 X 2 ANOVA of Students' Performance in Mathematics by Treatments, Gender and School Location**

Source	SS	Df	MS	F	P
Corrected Model	7048.803	12	587.400	48.538	0.000
Covariate (Pretest)	386.225	1	386.225	31.915	0.000
Group	4556.103	2	2278.051	188.240	0.000
Gender	7.303	1	7.303	0.603	0.438
Location	10.546	1	10.546	0.871	0.352
Group * Gender	41.075	2	20.537	1.697	0.186
Group * Location	35.639	2	17.819	1.472	0.232
Gender * Location	9.443	1	9.443	0.780	0.378
Group * Gender * Location	103.447	2	51.724	4.274	0.015
Error	2650.300	219	12.102		
Total	82156.000	232			
Corrected Total	9699.103	231			

**P<0.05** Table 11 showed that the computed  $F_{2,219}=4.274$ ,  $P<0.05$  was statistically significant at 0.05 level. The null hypothesis was rejected. This implied that there was interaction effects of treatments, gender and school location on students' performance in Mathematics.

**Hypothesis 8:** There is no interaction effects of treatments, gender and school location on students' attitude towards Mathematics.

**Table 12: 3 X 2 X 2 ANOVA of Students' Attitude Towards Mathematics by Treatments, Gender and School Location**

Source	SS	Df	MS	F	P
Corrected Model	6919.213	12	576.601	8.628	0.000
Covariate (Pretest)	2821.894	1	2821.894	42.228	0.000
Group	1516.161	2	758.081	11.344	0.000
Gender	59.948	1	59.948	0.897	0.345
Location	393.924	1	393.924	5.895	0.016
Group * Gender	258.742	2	129.371	1.936	0.147
Group * Location	33.163	2	16.582	0.248	0.780
Gender * Location	14.486	1	14.486	0.217	0.642
Group * Gender * Location	1141.788	2	570.894	8.543	0.000
Error	14634.886	219	66.826		
Total	961741.000	232			
Corrected Total	21554.099	231			

**P<0.05**

Table 12 depicted that the computed  $F_{2,219}=8.543$ ,  $P<0.05$  was statistically significant at 0.05 level. The null hypothesis was therefore rejected. By implication, there was interaction effects of treatments, gender and school location on students' attitude towards Mathematics.

### Discussion

The findings of the study established the homogeneity and equity in the three groups in both urban and rural areas before treatments in mathematics. Consequently, the significant differences recorded afterwards were not ascribed to chance, but to the specific treatments applied. The result of the study showed significant differences in the performance and attitudinal mean scores of students in the experimental and control groups after treatment. However, think-pair-share instructional strategy had better effect on students' performance and attitude towards mathematics. The result of the study further showed that school location had no effect on students' performance and attitude towards Mathematics using activity-based and think-pair-share instructional strategies.

### Conclusion

Based on the findings, it was concluded that both experimental and control groups were homogenous prior to treatments in Mathematics. It was also concluded that both activity-based and think-pair-share instructional strategies were effective for the teaching of Mathematics in senior secondary schools.

### Recommendations

Based on the findings, the following recommendations were made:

- Mathematics teachers should adopt activity-based and think-pair-share instructional strategies to teach the students in both urban and rural senior secondary schools in Ekiti State to encourage self-construction of knowledge;
- Students (male and female) should be encouraged by their Mathematics

teachers by giving them opportunities of having hand-on-activities, personal-thinking, pairing and sharing of ideals to gear up their senses of belongings in Mathematics class;

- The curriculum planners, Ekiti State Ministry of Education, society and Parents should help in implementation of activity-based and think-pair-share instructional strategies to teach Mathematics in schools.

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## INFLUENCE OF TECHNOLOGICAL TOOLS ON SECONDARY SCHOOL STUDENTS' STUDY HABIT IN PHYSICS IN KWARA STATE, NIGERIA

BY

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### Abstract

*This study examined the influence of technological tools on the study habits of secondary school students in Physics in Kwara State, Nigeria. A descriptive survey research design was adopted. The population comprised senior secondary school III Physics students, from whom a sample was selected using multistage sampling techniques. Data were collected using a validated questionnaire titled Technological Tools and Study Habits Questionnaire (TTSHQ). Descriptive statistics and inferential statistics were used for data analysis. Findings revealed that students had access to technological tools such as smartphones, scientific calculators, laptops, and internet resources, and that these tools significantly influenced their study habits in Physics by improving time management, independent learning, and engagement with Physics content. Significant differences were found in students' study habits based on gender and school location. The study concluded that technological tools positively influence Physics students' study habits and recommended improved access to relevant technologies and structured guidance on their academic use.*

**Keywords:** Technological tools, Study habits, Physics, Gender, Location, Secondary school students

### Introduction

Education remains the bedrock of national development and a powerful instrument for social transformation and technological advancement. In recent years, the growing emphasis on science, technology, engineering, and mathematics (STEM) has placed increasing importance on Physics as a core subject in secondary school curricula across Nigeria. Physics serves as the foundation for understanding the principles underlying scientific and technological progress, contributing significantly to innovations in medicine, engineering, and industrial design. Despite its importance, the teaching and learning of Physics at the secondary school level in Nigeria continue to encounter several challenges, particularly those related to students' poor study habits, inadequate instructional

materials, and low utilization of modern technological tools (Abdullahi & Oyeleke, 2021).

Technological tools, particularly hardware devices such as projectors, computers, smartboards, simulation kits, and laboratory apparatus, have revolutionized the delivery of education in many developed and developing countries. These tools are central to enhancing active learning, visualization of abstract concepts, and the development of practical skills necessary for mastering Physics. According to Bello and Olagunju (2022), integrating such tools into the learning process helps to bridge the gap between theoretical explanations and real-world applications, thereby improving comprehension, retention, and students' overall study habits. The use of hardware

technology in the classroom also encourages self-directed learning, collaboration, and critical thinking skills essential for success in the modern knowledge economy.

In the context of Nigeria's educational system, the Federal Government has continued to promote the integration of technological devices into school systems through initiatives such as the National Policy on Information and Communication Technology (ICT) in Education. This policy emphasizes the use of technological hardware such as computers, interactive whiteboards, and digital projectors in classrooms to enhance learning efficiency and make teaching more student-centered (Federal Ministry of Education, 2021). However, despite the existence of these policies, studies such as those by Oduwaiye *et al.* (2023) and Yusuf and Adeoye (2022) have shown that the level of utilization of technological tool in Nigerian secondary schools remains low due to infrastructural deficiencies, erratic electricity supply, inadequate training of teachers, and insufficient access to modern teaching resources, especially in rural areas.

Physics education requires a high level of visualization and experimentation, and this is where hardware technological tools play a critical role. Unlike purely theoretical subjects, Physics concepts often demand empirical demonstrations for students to understand and internalize abstract ideas such as motion, energy, electricity, and magnetism. For instance, projectors and smartboards can be used to display visual simulations of complex physical phenomena, while laboratory tools such as oscilloscopes, voltmeters, and motion sensors can help students perform experiments that concretize theoretical knowledge. According to findings by Eze and Ekwueme (2020), students who learn Physics through hardware-based technology-assisted instruction demonstrate better conceptual understanding and improved study habits than those taught through conventional lecture methods. These technological innovations provide students with opportunities to learn at their own pace, revisit instructional materials, and engage

in self-assessment, all of which are essential to the development of effective study habits.

The concept of study habits encompasses the range of strategies, routines, and behaviors that students adopt to acquire, organize, and retain academic knowledge. Effective study habits are strongly correlated with academic achievement, motivation, and persistence in learning (Okoye & Akinola, 2022). In Physics, where understanding is cumulative and heavily dependent on consistent practice, study habits determine students' mastery of fundamental principles and their ability to apply them to problem-solving. The introduction of technological hardware tools has transformed these habits by shifting learning beyond the conventional classroom environment. Students now access multimedia content, perform simulations, and engage in virtual laboratories that complement traditional study approaches. According to Adetunji and Olayinka (2023), students who engage with technological tools develop greater autonomy in learning, display increased interest in scientific inquiry, and demonstrate better retention of Physics concepts. However, the extent to which technological tools influence students' study habits in Physics varies according to contextual factors such as gender and location. Gender has long been recognized as a significant variable influencing students' attitude toward science and technology-based learning. Some studies in Nigeria (Olabode & Jimoh, 2021; Adepoju *et al.*, 2023) have reported that male students are more confident and willing to engage with hardware tools like computers and laboratory equipment, while female students may exhibit anxiety or limited interest due to societal expectations and stereotypes that associate technology use with masculinity. Nevertheless, other findings (Adeniran & Sanni, 2022) indicate a gradual narrowing of this gap, as more female students are beginning to embrace technology for learning, particularly with the integration of interactive and user-friendly educational platforms.

The influence of gender differences on study habits also manifests in how male

and female students allocate time, seek help, and approach problem-solving in Physics. Males tend to exhibit exploratory tendencies and enjoy experimental engagement with physical devices, while females often rely more on structured study routines and collaborative learning (Adebayo & Nwosu, 2023). Technological hardware such as data loggers, projectors, and interactive models may, therefore, appeal differently to students based on their preferred learning approaches. Consequently, any study on the influence of technological tools on study habits must account for these gender-related patterns to provide a balanced understanding of how technology supports learning in Physics classrooms.

In addition to gender, the location of schools (whether urban or rural) significantly shapes access to and utilization of technological tools. Urban schools, particularly those in metropolitan areas such as Ilorin and Offa in Kwara State, are more likely to be equipped with digital infrastructure, electricity, and well-trained personnel capable of operating modern educational devices (Olatunji & Aremu, 2022). Conversely, rural schools often face infrastructural deficits, lack of internet access, and inadequate funding, which limit the effective integration of hardware technologies into Physics teaching and learning. This disparity directly influences the study habits of students, as urban learners may rely on electronic resources and multimedia study materials, while their rural counterparts remain dependent on traditional textbooks and rote learning approaches. A study by Alabi and Ibrahim (2023) found that Physics students in urban areas demonstrated more interactive and technology-supported study routines compared to those in rural areas, who exhibited passive and teacher-dependent learning behaviors.

The study habits of Physics students in Kwara State, therefore, cannot be understood without considering both gender and location as moderating variables in the use of technological tools. Kwara State, which is geographically located in the North-Central region of Nigeria, presents a diverse educational

landscape characterized by both urban and rural settlements. The state has made substantial progress in expanding access to education through government interventions and partnerships with non-governmental organizations, yet disparities persist in the distribution of technological resources across schools. Urban schools tend to have better access to hardware tools such as projectors, computers, and laboratory apparatus, whereas many rural schools still rely on outdated teaching materials. This imbalance contributes to differences in students' learning experiences and study behaviors (Lawal & Yusuf, 2024).

Physics remains one of the most conceptually challenging subjects in secondary schools in Nigeria, as it requires not just memorization but a deep understanding of abstract concepts and the ability to apply them in real-world contexts. Studies have consistently shown that Nigerian students perform poorly in Physics in public examinations, partly due to ineffective study habits and limited access to instructional technology (Oyelekan & Olatunbosun, 2021). The West African Examinations Council (WAEC) Chief Examiners' reports over the years have highlighted students' inability to grasp key concepts such as kinematics, energy transformation, and electromagnetism. This challenge calls for the adoption of technological hardware tools that can enhance conceptual understanding and stimulate students' curiosity through demonstration and experimentation. According to Adeyemo (2023), the use of interactive devices and digital laboratories in Physics classrooms promotes active participation and makes the learning process more engaging and meaningful.

Technological tools, especially hardware, do not merely serve as instructional aids but function as mediating instruments that transform students' cognitive processes and learning strategies. For example, when students engage with an interactive whiteboard, they visualize real-time diagrams and experiment outcomes, which strengthen their comprehension of Physics concepts. Similarly, laboratory hardware such as digital sensors and simulation kits enables students to link theoretical equations to

observable phenomena. According to findings by Musa and Ajiboye (2022), students exposed to such interactive technologies developed stronger analytical and problem-solving skills, leading to improved academic performance. These positive outcomes are strongly associated with better-organized study habits, as learners become more engaged, motivated, and independent in managing their study schedules.

The emergence of modern pedagogical models that integrate technological tools into Physics instruction has also transformed the role of teachers and students. Teachers are no longer the sole source of knowledge but facilitators who guide learners through technology-enhanced inquiry processes. Students, on the other hand, have become active participants, exploring, experimenting, and constructing knowledge through technological interfaces. According to Yusuf and Afolabi (2023), such a paradigm shift promotes the development of scientific attitudes, curiosity, and a growth mindset among students. This, in turn, shapes study habits characterized by persistence, regular practice, and self-evaluation.

### **Purpose of the Study**

The main purpose of the study was to investigate the influence of technological tools on the study habit of secondary school students in Physics in Kwara State.

This study specifically sought to:

- i. identify the types of technological tools available to students for studying Physics
- ii. examine the frequency of usage of the available technological tools
- iii. assess the influence of Technological tools on Students' Study habit

### **Research Questions**

The following research questions were raised to guide this study

1. What are the types of technological tools available to secondary school students for studying Physics?

2. How frequently do students use technological tools to support their study habit?
3. What are the influence of technological tools on students' study habit in Physics?

### **Research Hypotheses**

The following research hypotheses were formulated to guide the study:

1. There is no significant relationship between the use of technological tools and students' study habits in Physics.
2. There is no significant difference in the study habits of male and female students in senior secondary school in Physics.
3. There is no significant difference between student study habit in urban and rural areas.

### **Methodology**

This study adopted a descriptive survey design with an evaluative component to investigate the influence of Technological tools on secondary school students' study habits in Physics in Kwara state, Nigeria. Descriptive survey is appropriate because inference would be drawn for the purpose of generalization to gather information from a representation of students. The population for the study comprised all 3220 S.S.3 students offering Physics in public senior secondary schools across the sixteen local government areas of Kwara State. This is in accordance with the data obtained from the Kwara State Ministry of Education (2024). The sample for this study consisted of 240 S.S.3 Physics students selected through Multistage sampling procedure. The first stage involved the selection of one out of the three senatorial districts in Kwara State using simple random technique. Stage two involved the use of simple random sampling technique to select three local Government from Kwara South Senatorial district. Stage three involved the use of stratified random sampling technique and also purposive random sampling technique to select six public secondary schools from the local governments earlier selected bearing in mind location (a school each from rural area and urban

area) who were technological tools are available.

The only instrument used to collect data for the study was a questionnaire developed by the researcher, titled, Influence of Technological Tool on secondary school students study habits Questionnaire (ITTSSSSHQ). The instrument consisted of four sections, A to D. Section A elicited information on respondents' bio-data such as gender and class. Section B elicited information on the types of technological tools available in the school. Section C requested information about the study habits of the respondents while section D elicited information on the influence of technological tools on the study habits of the respondents on a four-point likert scale of Strongly Agree (4points), Agree (3points), Disagree (2points) and Strongly Disagree (1point). The respondents were required to indicate the choice that best represents their opinion on each item.

The validity of the instrument was ascertained by giving it to experts in Science Education and Tests and measurement respectively for face and content validity. All the corrections made by these experts were effected and used for data collection.

**Table 1: Frequency and Percentage analysis of availability of technological tools to secondary school students for studying Physics**

S/N	Technology Tools	Available		Not Available	
		F	%	F	%
1.	Scientific calculators	240	100.00	0	0.0
2.	Projectors	48	20.0	192	80.0
3.	Smart boards/Interactive whiteboards	144	60.0	96	40.0
4.	Digital multimeters	192	80.0	48	20.0
5.	Electronic timers	48	20.0	192	80.0
6.	Laptops or desktops for physics simulations	144	60.0	96	40.0
7.	Digital thermometers	96	40.0	144	60.0
8.	Digital voltmeters/ammeters	192	80.0	48	20.0
9.	Electricity circuit training boards	48	20.0	192	80.0
10.	Rechargeable light sources	144	60.0	96	40.0
11.	Functional laboratory apparatus (modern)	192	80.0	48	20.0
12.	LCD display tools for physics data	192	80.0	48	20.0

Table 1 revealed the types of technological tools available to secondary school students for studying Physics. Schools with the technological tools are classified as available and schools without

The reliability of the research instrument (ITTSSSSHQP) was determined through a trial test conducted on 30 students outside the sampled schools. The data collected were subjected to Cronbach Alpha reliability testing which yielded a coefficient value of 0.78, which was considered high enough to declare the instrument reliable for the study.

The Instrument (ITTSSSSHQP) was administered by the researcher and also with the help of a research assistant. The data collected through the instrument were analysed using descriptive and inferential statistics. The research questions were answered using mean, standard deviation and bar chart. Hypotheses 1 was tested using Pearson's Product Moment Correlation Analysis (PPCMA) while Hypotheses 2 and 3 were tested using t-test. Decision was taken at 0.05 level of significance.

## Results

### Research Questions

**Research Question 1:** What are the types of technological tools available to secondary school students for studying Physics?

any are classified as not available. The table revealed that majority of the sampled schools have adequate technological tools. The table also revealed that the highest available

technological tools are the scientific calculators with 100%, Digital multimeters, Digital voltmeters/ammeters, functional laboratory apparatus (modern), LCD display tools for physics data with 80% of the sampled schools having them in their schools. The table further revealed that the lowest available

technological tools are the Projectors, Electronic timers, and Electricity circuit training boards with 20% of the sampled schools having them in their schools.

**Research Question 2:** How frequent do students use technological tools to support their study habit?

**Table 2: Frequency and Percentage analysis of utilization of Technological tools to support their Study habit**

S/N	Technology Tools	Very Frequently		Frequently		Occasionally		Rarely		Never	
		VF	%	F	%	F	%	F	%	F	%
1	Scientific calculators	209	87.1	31	12.9	0	0.00	0	0.00	0	0.00
2	Projectors	33	13.8	6	2.5	8	3.3	1	0.4	192	80.0
3	Smart boards/Interactive whiteboards	141	58.8	2	0.8	0	0.00	0	0.00	97	40.4
4	Digital multimeters	127	52.9	9	3.8	45	18.8	8	3.3	51	21.3
5	Electronic timers	38	15.8	2	0.8	9	3.8	0	0.00	191	79.6
6	Laptops or desktops for physics simulations	119	49.6	1	0.4	20	8.3	2	0.8	98	40.8
7	Digital thermometers	65	27.1	4	1.7	26	10.8	1	0.4	144	60.0
8	Digital voltmeters/ammeters	149	62.1	8	3.3	35	14.6	0	0.00	48	20.0
9	Electricity circuit training boards	41	17.1	3	1.3	4	1.7	0	0.00	192	80.0
10	Rechargeable light sources	140	58.3	1	0.4	2	0.8	0	0.00	97	40.4
11	Functional laboratory apparatus (modern)	177	73.8	13	5.4	2	0.8	0	0.00	48	20.0
12	LCD display tools for physics data	165	68.8	26	10.8	0	0.00	0	0.00	49	20.4

Table 2 revealed the extent to which Students use Technological tools to support their Study habit. The table revealed that Scientific calculators, Smart boards/Interactive whiteboards, Digital multimeters, Digital voltmeters/ammeters, and Rechargeable light sources were very frequently utilized by over 50% of the sampled schools as other facilities were not very frequently utilized by majority of the sampled schools. The table also revealed that the highest very frequently

utilized technological tools by the sampled schools was scientific calculators with 87.1% of the sampled schools very frequently utilized it. The table above revealed that most of the teachers did not utilize the Technological tools as expected for the teaching and learning of Physics.

**Research Question 3:** What are the influence of technological tools on students' study habit in Physics?

**Table 3: Descriptive Analysis of the influence of Technological tools on Students' Study habit in Physics**

S/N	Perceptions on the influence of Technological tools on Students' Study habit in Physics	SA (%)	A (%)	D (%)	SD (%)	Mean	Standard Deviation	Remark
1	I regularly use Scientific calculators in solving Physics problems	95 (39.6)	94 (39.2)	23 (9.6)	28 (11.7)	3.08	0.94	Agree
2	The use of projectors and smart board during physics lessons help me understand topics better	96 (40.0)	96 (40.0)	24 (10.0)	24 (10.0)	3.10	0.95	Agree
3	Physics laboratory equipment enhances my interest and engagement in the subject	96 (40.0)	95 (39.6)	26 (10.8)	23 (9.6)	3.10	0.94	Agree
4	Access to modern laboratory tools improves my ability to conduct experiments	95 (39.6)	96 (40.0)	25 (10.4)	24 (10.0)	3.09	0.95	Agree
5	I prefer using digital measuring instruments (e.g digital multimeters, electronic timers) over traditional ones	71 (29.6)	120 (50.0)	25 (10.4)	24 (10.0)	2.99	0.89	Agree
6	I find it easier to study physics when using technology enhanced classroom equipment like interactive whiteboard	91 (37.9)	96 (40.0)	29 (12.1)	24 (10.0)	3.06	0.95	Agree
7	I am more motivated to learn when my school provides modern physics technology tools	95 (39.6)	96 (40.0)	25 (10.4)	24 (10.0)	3.09	0.95	Agree
8	Sufficient access to use technology tools facilitate the effective learning of physics	48 (20.0)	144 (60.0)	24 (10.0)	24 (10.0)	2.90	0.83	Agree
9	Technology tools use in Physics helps me retain information better	96 (40.0)	96 (40.0)	24 (10.0)	24 (10.0)	3.10	0.95	Agree
10	Technology tools encourage student to work together collaboratively	95 (39.6)	95 (39.6)	26 (10.8)	24 (10.0)	3.09	0.95	Agree

**Cut -Off Mean; 2.5**

Table 3 identified the Perceptions on the influence of technological tools on students' study habit in Physics. Using a cut-off mean of 2.50 for the rating scale. All the respondent agreed on the positive influence of technological tools on students' study habit in Physics. It indicates that technological tools have potent to positively influence students' study habit in Physics.

**Hypotheses Testing**

**Hypothesis 1:** There is no significant relationship between the use of technological tools and students' study habits in Physics.

In testing this hypothesis, data on the use of technological tools and students' study habits in Physics were collected from the responses of the respondents to items 1-12 in section C of frequency of usage of technological tools in Physics learning and item 1-10 in section D of Influence of technological tools on Physics students study habits were used to compile this data. Pearson's product-moment correlation tests were performed at the 0.05 level to determine statistical significance. Table 4 displays the final result.

**Table 4: Relationship between the use of technological tools and students' study habits in Physics**

Variables	N	Mean	Stand Dev	r-cal	P-value
the use of Technological tools	240	33.96	11.44	0.313*	0.000
Students' Study habits	240	30.60	7.99		

\*P<0.05

Table 4 showed that the r-cal value of 0.313 is significant at 0.05 level of significance because the P-value (0.000) < 0.05. The null hypothesis is rejected. This implies that there is significant relationship between the use of technological tools and students' study habits in Physics.

**Hypothesis 2:** There is no significant difference in the Study habits of male and female Students in Senior Secondary School in Physics.

The difference in the study habits of male and female students in senior secondary school in Physics was analyzed using a t-test for statistical significance at the 0.05 level to evaluate the hypothesis. Table 5 presents the conclusive outcome.

**Table 5: t-test analysis for the study habits secondary school in Physics**

Variations	Gender	N	Mean	SD	df	t	P
Students' Study Habits	Male	80	30.91	7.87	238	0.422	0.674
	Female	160	30.45	8.08			

p>0.05

Table 5 shows that the t-cal value of 0.422 is not significant because the P value (0.674) > 0.05 at 0.05 level of significance. This indicates that the null hypothesis was not rejected. Consequently, there is no significant difference in the Study habits of male and female Students in Senior Secondary School in Physics.

**Hypothesis 3:** There is no significant difference between Student Study habit in Urban and Rural areas in Physics.

The difference in the Study habits in Urban and Rural areas of Students in Senior Secondary School in Physics was analyzed using a t-test for statistical significance at the 0.05 level to evaluate the hypothesis. Table 6 presents the conclusive outcome.

**Table 6: t-test analysis for the study habits in urban and rural areas of students in senior secondary school in Physics**

Variations	Gender	N	Mean	SD	df	t	P
Students' Study Habits	Urban	144	30.18	8.11	238	1.005	0.316
	Rural	96	31.24	7.83			

p>0.05

Table 6 shows that the t-cal value of 1.005 is not significant because the P value (0.316) > 0.05 at 0.05 level of significance. This indicates that the null hypothesis was not rejected. Consequently, there is no significant difference between Students Study habit in Urban and Rural areas in Physics.

This study revealed that there was significant relationship between the use of technological tools and students' study habits in Physics. This study was consistent with the submission of Okeke and Onuoha (2021) who documented that learner in Enugu State secondary schools developed habits of collaborative discussion when projectors and multimedia devices were introduced into their classrooms. Rather than studying in

**Discussion**

isolation, students increasingly participated in cooperative revision sessions, engaging in peer teaching and collaborative questioning that enhanced collective understanding. In a similar study, Kumar and Singh (2020), who observed that collaborative study habits flourished in environments where technological tools facilitated group interaction. Such practices are particularly valuable in subjects like Physics, where problem-solving benefits greatly from cooperative reasoning. In a corresponding research effort.

Singh (2020), observed that collaborative study habits flourished in environments where technological tools facilitated group interaction. Such practices are particularly valuable in subjects like Physics, where problem-solving benefits greatly from cooperative reasoning.

The study revealed that there was no significant difference in the Study habits of male and female Students in Senior Secondary School in Physics. This study is not in agreement with the perspective offered by Yusuf and Adeoye (2021) that showed that female students are more inclined to use digital tools for multitasking activities, such as listening to recorded lectures while preparing assignments or revising notes while participating in online discussion forums. Male students, however, reported a higher tendency toward task-switching across academic and non-academic platforms, often blending study with recreational technology use such as gaming or social media browsing. In a similar study, Adeyemi and Ojo (2021), asserted that male students in Physics are more likely to engage with digital simulations, online problem-solving platforms, and virtual laboratories. Female students, on the other hand, frequently adopt technology for organizational purposes such as structuring study notes, accessing online tutorials, and joining collaborative learning communities.

The study revealed that there was no significant difference between Student Study habit in Urban and Rural areas. This finding was not aligning with the assertion of Eze and Uzoechi (2020) who stated that students in urban areas are significantly more likely to access online learning platforms, e-books, and

multimedia study aids than their rural counterparts. In a corresponding research effort, Olaniyi and Omotayo (2022) emphasized that rural Physics students faced greater obstacles in developing problem-solving strategies because of their limited exposure to digital simulations that illustrate abstract principles.

### Conclusion

Sequel to the findings of this study, it was concluded that the use of technological tools has a positive and significant influence on students' study habits in physics. No significant differences were found in study habits based on gender or school location (urban or rural), indicating that technology supports equitable learning.

### Recommendations

Based on the findings of this study, the following recommendations were made.

1. Government and educational stakeholders should provide adequate funding for the procurement of poorly available technological tools such as projectors, electronic timers, and electricity circuit training boards in senior secondary schools.
2. School administrators should ensure equitable distribution of technological tools to both urban and rural schools to sustain uniform improvement in students' study habits in physics.
3. Regular training and professional development programs should be organized for physics teachers to enhance effective utilization of both available and underutilized technological tools.
4. Schools should develop maintenance and replacement plans to keep existing technological tools functional and encourage their continuous use during physics instruction.
5. Physics teachers should be encouraged to integrate a wider range of technological tools into daily teaching practices to further improve students' study habits and learning outcomes.
6. Curriculum planners should emphasize technology-based teaching strategies in physics syllabi, promoting active learning and improved study habits among students.

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