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EDITORIAL

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O. I. Oginni Ph.D

Editor-in-Chief

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EFFECTS OF TEAM TEACHING ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN BIOLOGY IN EKITI STATE, NIGERIA

BY

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Abstract

This study examined the effects of team teaching on secondary school students' academic performance in Biology in Ekiti State, Nigeria. The study adopted a quasi-experimental research design of the pre-test, post-test control group type. The population consisted of 16,721 SS II students in 206 public secondary schools across Ekiti State, from which 87 students were selected using a multistage sampling procedure. The Performance Test in Biology (PTB) was used for data collection. The instrument was validated by experts in Biology Education and Measurement and Evaluation, and its reliability was established using the test-re-test method, yielding a reliability coefficient of 0.93. The experimental procedure involved three stages: pre-treatment, treatment, and post-treatment. The PTB was administered as a pre-test to establish baseline equivalence between groups. During the six-week treatment period, the experimental group was taught Biology topics (reproduction, respiratory system, and excretory system) using team teaching, while the control group was taught using the conventional method. Each group received three 40-minute lessons per week. After treatment, the PTB was re-administered with reshuffled items on the two groups. Data were analyzed using descriptive and inferential statistic. The research question was answered using descriptive statistics of mean and standard deviation while the hypotheses were tested using t-test statistics at 0.05 level of significance. Findings revealed no significant difference between the groups at the pre-test stage, indicating homogeneity. However, students taught using team teaching performed significantly better than those taught using the conventional method after treatment. The study concluded that team teaching is an effective instructional strategy for improving students' academic performance in Biology. It was recommended that secondary schools teacher should adopt team teaching to enhance Biology learning outcomes.

Keywords: Academic performance, Conventional, secondary school, students, Team Teaching.

Introduction

Biology education is very important in secondary schools because it provides students with knowledge about living organisms, their structures, functions, and interactions with the environment. It helps students understand basic life processes such as growth, reproduction, and health maintenance, which are essential for personal and community well-being. Biology also prepares students for science-based careers such as medicine, agriculture, biotechnology, environmental science, and nursing (Okoli and Eze, 2022). In addition, Biology education promotes scientific literacy, critical thinking, and problem-solving skills, which are necessary for making informed decisions on issues related to health, environment, and technological development (Olanrewaju and Balogun, 2023). In Nigeria, Biology education contributes to national development by supporting public health improvement, food security, biodiversity conservation, and environmental sustainability.

Students' performance in Biology has remained a concern in secondary school education because of persistent poor achievement in the subject. Biology is often regarded as a difficult science subject due to its abstract concepts, terminologies, and the need for practical understanding of biological processes (Aremu, 2018). In many Nigerian secondary schools, poor academic performance in Biology has been linked to the use of teacher-centered instructional methods that limit students' active participation in learning (Akinbobola

and Afolabi, 2019). In addition, inadequate laboratory facilities and insufficient exposure to practical Biology experiments have contributed to students' low understanding of biological concepts, which negatively affects academic performance (Ogunleye, 2017). Students' attitudes toward Biology also play a role in their performance, as students who show low interest in the subject tend to perform poorly in assessments (Olatoye, 2019). Furthermore, other factors such as shortage of qualified Biology teachers, large class sizes, and lack of instructional resources have been reported to affect students' achievement in Biology in Nigerian secondary schools (Ahmed, 2020). Poor performance in Biology examinations has implications for students' future career opportunities in science-related fields, making it necessary to explore effective teaching strategies that can improve academic achievement in the subject (Aremu, 2018).

Teaching methods play a significant role in determining students' academic performance in Biology because they influence how well students understand biological concepts. Effective teaching requires the use of strategies that encourage active student participation, critical thinking, and practical application of knowledge (Adunola, in 2020). In many secondary schools, teacher-centered methods such as the lecture method have been widely used, but such approaches often limit students' interaction and practical engagement with Biology concepts, which may negatively affect performance (Akinbobola and Afolabi, 2019). Student-centered instructional strategies tend to improve academic achievement in Biology because they promote collaboration, discussion, and problem-solving skills (Oloyede, in 2022). Instructional effectiveness is also enhanced when teachers use appropriate teaching aids, laboratory activities, and real-life examples to explain Biology concepts (Ogunleye, 2017). In addition, innovative teaching strategies such as cooperative learning, inquiry-based learning, and team teaching have been found to improve students' understanding and performance in Biology (Slavin, 2014; Aremu, 2018). In Nigeria, improving instructional effectiveness in Biology is essential for raising students' academic performance and preparing them for science-related careers and national development (Olatoye, 2019). Therefore, the choice of teaching method remains a critical factor in determining students' success in Biology education.

Team teaching is a collaborative instructional approach in which two or more teachers jointly plan, teach, and evaluate lessons for the same group of students (Murphy, Hall, & Green, 2020). This strategy promotes shared responsibility, allows teachers to combine their strengths, and supports diverse instructional techniques in the classroom. In contrast to traditional single-teacher methods, team teaching encourages active student engagement, peer interaction, and differentiated instruction, all of which are linked to improved academic outcomes.

In Biology education, team teaching is especially valuable because the subject includes both theoretical concepts and practical laboratory activities that students often find challenging. With multiple teachers present, there is greater opportunity for real-time clarification, demonstration, and targeted support for students who struggle, which can enhance understanding of complex biological ideas (Smith & Johnson, 2021). Additionally, team teaching allows for the integration of varied teaching methods such as inquiry-based learning, group discussion, and hands-on activities within a single lesson, making learning more interactive and meaningful (Lee, 2022). Recent studies suggest that collaborative teaching approaches can improve students' performance in science subjects by fostering a supportive learning environment and increasing learner participation (Ademola & Yusuf, 2023; Chukwu & Obi, 2024). In light of these findings, investigating the effect of team teaching on students' academic performance in Biology is necessary, especially in secondary schools in Ekiti State, Nigeria.

Several recent studies have examined the impact of instructional strategies on students' academic performance, particularly in science subjects like Biology. Ademola and Yusuf (2023) investigated the effects of collaborative instructional strategies on senior secondary school students' Biology achievement and found that learners exposed to team-based teaching approaches performed significantly better than those

taught using traditional methods. Their study highlighted that cooperative planning and shared delivery among teachers helped clarify difficult concepts and increased students' engagement during lessons. Similarly, Chukwu and Obi (2024) examined the influence of team teaching on secondary school science performance and reported that students taught through team teaching experienced higher conceptual understanding and improved test scores compared to peers taught via conventional lecture methods. Their findings suggested that team teaching facilitated more meaningful classroom interaction, peer support, and differentiated instruction, which contributed to improved academic outcomes. In addition, Esan and Adeyemi (2022) studied the effect of co-teaching models on students' performance in Biology and showed that co-teaching enhanced practical skill acquisition and reduced students' anxiety toward laboratory exercises. The researchers attributed this improvement to increased teacher support and real-time feedback during learning activities. Furthermore, Oladele (2023) explored how collaborative teaching approaches influence students' attitudes and performance in senior secondary Biology and found a positive relationship between group-oriented instructional practices and learners' examination results, noting that students who participated in team-oriented lessons demonstrated greater interest and higher achievement levels. While these studies indicate that collaborative and team-based instructional strategies can positively influence students' performance in Biology and other sciences, few have focused specifically on team teaching in Ekiti State, Nigeria.

Therefore, this study seeks to examine the effects of team teaching on secondary school students' academic performance in Biology in Ekiti State, Nigeria, and by comparing the performance of students exposed to team teaching with those taught using the conventional method.

Statement of the Problem

Students' academic performance in Biology at the secondary school level has continued to generate concern among educators, parents, and policymakers. Despite the importance of Biology as a core science subject and its relevance to career opportunities in medicine, agriculture, environmental science, and other science-related fields, many students record unsatisfactory achievement in internal and external examinations. This persistent poor performance has been attributed to several factors, particularly the continued reliance on conventional lecture methods that often limit students' active participation and practical engagement during lessons. Biology, by its nature, requires clear explanation of abstract concepts, demonstration of processes, and adequate practical exposure. However, in many secondary schools, instruction is predominantly teacher-centered, which may not effectively address students' learning difficulties or promote deep understanding of biological concepts. As a result, students may develop low interest in the subject, leading to poor academic outcomes. Although innovative instructional strategies such as collaborative and student-centered approaches have been recommended to improve learning outcomes, there is limited empirical evidence on the effectiveness of team teaching specifically in enhancing students' performance in Biology in Ekiti State, Nigeria. It therefore becomes necessary to investigate whether the use of team teaching can significantly improve students' academic performance in Biology compared to the conventional teaching method.

Purpose of the Study

The purpose of this study is to:

i. examine the effect of team teaching on students' academic performance in Biology; and
ii. comparethe academic performance of students taught Biology using team teaching and those taught using the conventional method.

Research Question

1. The following research question was raised to guide this study:
2. What is the performance of students in Biology before and after the treatments?

Research Hypotheses

The following hypotheses were formulated to guide this study:

1. There is no significant difference in the performance of students taught Biology using team teaching

strategy and conventional method before treatment.

2. There is no significant difference in the performance of students taught Biology using team teaching strategy and conventional method after treatment.

Methodology

This study adopted a quasi-experimental research design of the pre-test, post-test and control group design. The design involved two groups: an experimental group and a control group. Both groups were administered a pre-test to determine their level of homogeneity before the treatment. The experimental group was exposed to the team-teaching strategy, while the control group was taught using the conventional method. At the end of the treatment period, a post-test was administered to both groups to determine the effect of the instructional strategy on students' academic performance in Biology. The design can be represented as:

Experimental Group: O_1 X_1 O_2;

Control Group: O_3 Xc O_4,

Where: O_1 and O_3 represent pre-test observations,

O_2 and O_4 represent post-test observations,

X_1 represents the team teaching strategy, and

Xc represents the conventional teaching method.

The population of the study consisted of 16,721 Senior Secondary School Two (SS II) students in 205 public secondary schools across the 16 Local Government Areas of Ekiti State (Ministry of Education, Ekiti State, 2025). SS II students were considered appropriate for the study because the selected Biology topics—reproduction, respiratory system, and excretory system—are contained in the SS II scheme of work. A sample of 87 SS II students was selected using a multistage sampling procedure. Two senatorial districts were selected through simple random sampling, after which one Local Government Area (LGA) was selected from each district using simple random sampling. One public secondary school was then selected from each chosen LGA using stratified because it involves dividing a population into distinct subgroups random sampling, making a total of two schools. One intact SS II class was selected from each school through simple random sampling, and all students in the selected classes constituted the sample. The classes were randomly assigned to experimental and control groups. The instrument used for data collection was the Performance Test in Biology (PTB). The PTB consisted of two sections: Section A collected respondents' bio-data, while Section B contained 30 multiple-choice questions with four options (A–D) drawn from the SS II Biology scheme of work. Each correct response attracted one mark, while incorrect responses attracted zero. The same test items were reshuffled for the post-test to minimize test-wiseness and carry-over effects. The instrument was subjected to face and content validity by experts in Biology Education and Measurement and Evaluation, as well as experienced WAEC and NECO examiners. Their suggestions and corrections were incorporated before final administration. The reliability of the PTB was established using the test-retest method on 20 students outside the sampled schools. The scores obtained from the two administrations were analyzed using Pearson's Product Moment Correlation Coefficient, which yielded a reliability coefficient of 0.93, indicating that the instrument was reliable for the study. The experimental procedure was carried out in three stages: pre-treatment, treatment, and post-test. During the pre-treatment stage, permission was obtained from school authorities, and research assistants were trained. The pre-test was administered to obtain baseline data on students' performance in Biology. The treatment stage lasted six weeks, during which the experimental group was taught using the team teaching strategy, while the control group received instruction through the conventional method. Lessons were delivered for 40 minutes per period, three times per week, covering the selected topics. At the end of the treatment period, the post-test was administered to both groups. The data collected were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to

answer the research question, while t-test analysis was employed to test the hypotheses at the 0.05 level of significance.

Results

Research Question 1: What is the performance of students in Biology before and after the treatments?

Table 1: Mean and Standard Deviation of students' scores before and after treatments

Group	*N*	*Before*		*After*		*Mean Difference*
		Mean	*SD*	*Mean*	*SD*	
Team Teaching	42	52.4	6.8	78.1	7.5	25.7
Conventional Method	45	51.9	7.0	65.3	7.8	13.4

Table 1 shows the mean and standard deviation of students' scores in Biology before and after exposure to the two teaching methods. Students taught with the team teaching strategy (N = 42) had a pre-test mean score of 52.4 (SD = 6.8) and a post-test mean score of 78.1 (SD = 7.5), resulting in a mean difference of 25.7. On the other hand, students taught using the conventional method (N = 45) had a pre-test mean score of 51.9 (SD = 7.0) and a post-test mean score of 65.3 (SD = 7.8), with a mean difference of 13.4. These results indicate that while both groups improved after instruction, the improvement was greater for students exposed to team teaching, suggesting that the strategy had a stronger positive effect on academic performance in Biology. This further depicted in figure 1 below:

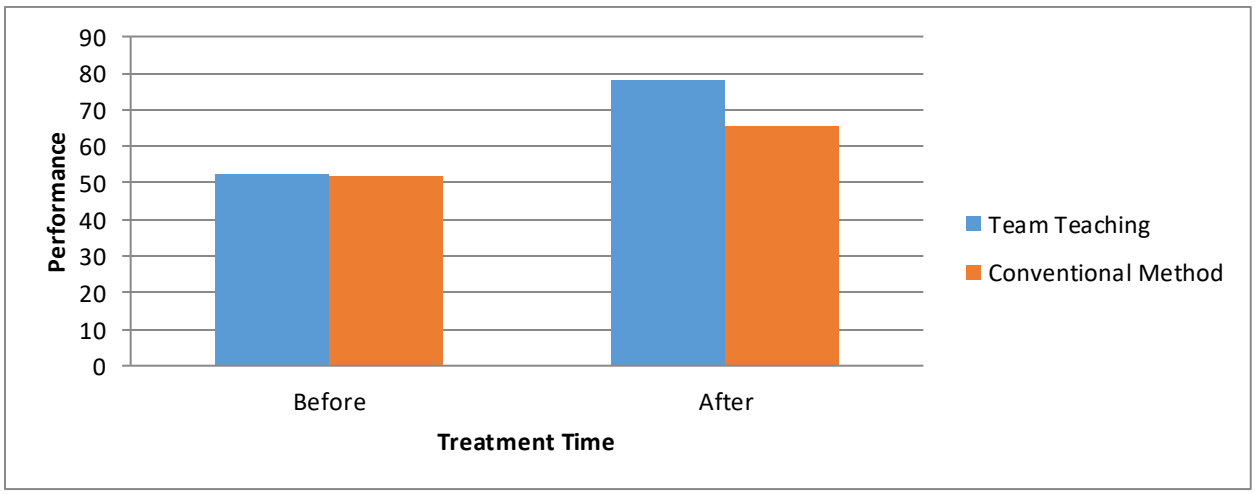

Figure 1: Bar Chart showing the performance of students in Biology before and after the treatments

Testing of Hypotheses

Hypothesis 1: There is no significant difference in the performance of students taught Biology using team teaching strategy and conventional method before treatment.

Table 2: t-test of students taught Biology using team teaching strategy and conventional method before treatment

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Team Teaching	42	52.40	6.80	85	0.42	0.676
Conventional Method	45	51.90	7.00			

$p<0.05$

Table 2 shows the result of the t-test comparing the pre-test scores of students taught Biology using the team teaching strategy and those taught with the conventional method. The mean score of the team teaching group (M = 52.40, SD = 6.80) was slightly higher than that of the conventional method group (M =

51.90, SD = 7.00). However, the difference was not statistically significant, t(85) = 0.42, p = 0.676, since the p-value is greater than 0.05. This indicates that both groups had comparable academic performance before the treatment, suggesting that the students started at the same baseline level.

Hypothesis 2: There is no significant difference in the performance of students taught Biology using team teaching strategy and conventional method after treatment.

Table 3: t-test of students taught Biology using team teaching strategy and conventional method

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Team Teaching	42	78.1	7.5	85	7.32	0.000
Conventional Method	45	65.3	7.8			

p<0.05

Table 3 presents the t-test result of the post-test scores of students taught Biology using the team teaching strategy and those taught with the conventional method. The mean score of the team teaching group (M = 78.10, SD = 7.50) was higher than that of the conventional method group (M = 65.30, SD = 7.80). The difference was statistically significant, t (85) = 7.32, p = 0.000, which is less than 0.05. This indicates that students taught with the team teaching strategy performed significantly better than those taught with the conventional method, showing the positive effect of team teaching on academic performance in Biology.

Discussion

The finding of this study revealed that team teaching significantly improved students' academic performance in Biology compared to the conventional method, as evidenced by the larger mean gain. This result is consistent with the findings of Oloyede and Adeyemi (2021), who reported that collaborative teaching strategies enhance students' understanding and retention of scientific concepts. The improvement may be attributed to the diverse instructional approaches and shared expertise of teachers in a team-teaching setting, which allows for differentiated explanations, immediate feedback, and increased engagement. Furthermore, this finding corroborated that of Akinola and Bello (2019), who found that students in team-taught classes demonstrated higher problem-solving skills and conceptual understanding in Science subjects. The interactive nature of team teaching likely fosters a richer learning environment, encourages peer discussion, and addresses individual learning needs more effectively than a single-teacher approach. However, Eze and Okeke (2022) found no significant difference in performance between team-taught and conventionally taught Biology classes, suggesting that the effectiveness of team teaching may depend on factors such as teachers' coordination, training, and class size. This implies that successful implementation requires careful planning and collaboration among educators. The implications of this finding are substantial for educational practice and policy. Schools may consider adopting team teaching as a strategy to enhance learning outcomes, particularly in challenging subjects like Biology.

The finding of this study revealed that there was no significant difference in the pre-test performance of students in both groups, indicating comparable baseline academic performance. This outcome is consistent with the opinion Creswell and Creswell (2023), who emphasized that establishing equivalence between groups prior to an intervention is essential for attributing post-test differences to the teaching method rather than pre-existing disparities. The similarity in baseline performance suggests that random assignment or careful grouping effectively controlled for initial academic ability, thereby strengthening the internal validity of the study. This ensures that any subsequent differences observed in post-test performance, attitudes, or engagement can be confidently linked to the instructional approach employed. The finding corroborated that reported by Oloyede and Adeyemi (2021) that there is no significant pre-test difference between groups in studies evaluating collaborative teaching strategies, highlighting the importance of comparable starting points in experimental educational research.

Another finding of this study is that students taught with team teaching performed significantly better in the post-test than those taught with the conventional method. This result is consistent with the submission of Oloyede and Adeyemi (2021), who found in their study that team teaching strategies enhance students' comprehension, retention, and application of scientific concepts. The observed improvement may be attributed to the interactive and supportive nature of team teaching, which allows multiple instructors to provide diverse explanations, immediate feedback, and address individual learning needs, thereby fostering deeper understanding. This finding also corroborated the finding of Akinola and Bello (2019), that students exposed to team-taught lessons demonstrated higher problem-solving skills and conceptual grasp in Science subjects. The presence of two or more teachers in the classroom encourages dynamic learning activities, stimulates peer discussion, and promotes engagement, which collectively enhance academic performance. However, Eze & Okeke, (2022) in their study reported contradictory results, noting no significant difference in post-test performance between team-taught and conventionally taught classes. Such discrepancies may be due to factors like inadequate teacher coordination, large class sizes, or differences in students' prior knowledge and motivation. The implications of this finding are significant for educational practice. Schools may consider adopting team teaching as an instructional strategy to improve student outcomes in challenging subjects such as Biology. Additionally, teacher training programs should emphasize collaborative instructional methods to ensure educators are well-equipped to implement team teaching effectively.

Conclusion

Based on the findings of this study, it was concluded that team teaching is an effective strategy for teaching Biology. Students who were taught using the team teaching approach performed better in tests than those taught using the conventional method. The collaborative and interactive nature of team teaching enhances lesson delivery, improves students' understanding of biological concepts, and promotes active participation in the learning process. Therefore, team teaching can be considered a viable instructional strategy for improving students' academic performance in Biology.

Recommendations

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

1. Schools should consider implementing team teaching in Biology classes, as it has been shown to improve both students' academic performance and attitudes toward the subject.
2. Teachers should be trained in collaborative and team-teaching strategies to ensure they can effectively plan and deliver lessons using this approach.
3. Educational planners should include opportunities for team-teaching methods in the school curriculum to enhance engagement and learning outcomes.
4. Schools should provide the necessary support, such as teaching assistants and resources, to ensure team teaching is implemented successfully.

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PRESERVICE TEACHERS' CONCEPTUAL UNDERSTANDING OF THE PRINCIPLES OF GREEN CHEMISTRY AND THEIR APPLICATIONS TO REAL-LIFE SITUATIONS

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Abstract

Green chemistry education plays a critical role in preparing future teachers to address sustainability challenges through informed chemical practices. This study investigated preservice chemistry teachers' conceptual knowledge and application of green chemistry and the influence of gender and their levels of study on knowledge and application of green chemistry. A descriptive survey design incorporating correlational and comparative analyses was employed, with a sample of 356 preservice chemistry teachers across 200, 300, and 400 level cohorts. The instrument adopted was validated both in conceptual knowledge and application of green chemistry. Data were analysed using descriptive statistics, Pearson's Product Moment correlation, independent samples t-test, one-way and two-way ANOVA, and regression analysis at the 0.05 significance level. Results revealed moderate levels of both knowledge and application, indicating partial integration of green chemistry concepts within teacher preparation. The finding also showed that there was a significant positive relationship between knowledge and application of green chemistry, confirming knowledge as a key predictor of sustainable practice. While gender showed no significant effect, level of study significantly influenced outcomes, with higher-level students demonstrating superior performance. It was therefore recommended that green chemistry should be introduced early and progressively across all levels of teacher education.

Keywords: Green chemistry, preservice teachers, sustainability education, conceptual understanding, application.

Introduction

Growing concerns about pollution, climate change, hazardous waste disposal, the depletion of natural resources, and unsustainable industrial and scientific practices have intensified the need for environmentally responsible scientific approaches. One major response to these concerns is green chemistry, which focuses on designing chemical products and processes that minimise or eliminate hazardous substances (Anastas & Warner, 1998). Green chemistry promotes waste prevention, safer solvents, renewable feedstocks, energy efficiency, pollution reduction and environmentally friendly chemical reactions.

In educational settings, green chemistry has become increasingly relevant because it helps learners understand the connection between chemistry and sustainable development. For preservice teachers, the relevance is even greater, as they are future educators who will shape learners' environmental attitudes and scientific practices. Consequently, there is a need to understand how preservice teachers acquire conceptual knowledge of green chemistry and how such knowledge translates into practical applications.

The constructivist theories of Piaget and Vygotsky emphasise that learners actively construct knowledge through interaction with their environment rather than passively receiving information (Piaget, 1972; Vygotsky, 1978). Learning becomes

meaningful when new ideas are linked to prior experiences and real-life situations.

This theory is particularly relevant to green chemistry education because students often understand sustainability concepts better when connected to visible issues such as waste disposal, water pollution, and excessive energy use. Preservice teachers who relate green chemistry principles to everyday realities are more likely to develop lasting conceptual understanding.

Kolb's experimental learning theory explains learning as a cyclical process involving concrete experience, reflection, abstract conceptualisation and active experimentation (Kolb, 1984). According to this view, learners understand concepts more deeply when they engage in practical activities and reflect on those experiences. Green chemistry aligns strongly with experiential learning because many of its principles are action oriented. Students learn better when they participate in eco-friendly laboratory experiments, waste audits, recycling projects and problem-solving tasks involving real environmental challenges.

Sunday et al. (2026) found that structured green chemistry instruction significantly improved students' understanding of concepts such as waste prevention, safer chemicals and environmental responsibility. Sunday et al. also noted that students in supportive, sustainability-oriented learning environments were more willing to adopt environmentally friendly practices. United Nations Educational, Scientific and Cultural Organisation, UNESCO (2024), similarly observed that inclusive and supportive educational settings reduce barriers to participation and encourage equal engagement in STEM-related fields. Similarly, Idul and Walag (2024) reported that curriculum integration enhanced students' comprehension of sustainability-related chemistry concepts. These findings suggest that learners build stronger knowledge when green chemistry is taught in meaningful contexts. Idul et al. (2025) found that students exposed to process-oriented guided inquiry learning modules demonstrated greater ability to apply green chemistry principles to waste reduction and sustainable decision-making.

Gunbatar et al. (2025) reported that effective green chemistry teaching commonly involves inquiry, laboratory redesign and sustainability-centred activities. However, where such approaches are absent, students often display only superficial awareness. They concluded in their systematic review that inquiry-based laboratories and hands-on learning approaches were more effective than lecture-only methods for promoting green chemistry competence. These findings imply that preservice teachers are more likely to apply green chemistry when learning experiences move beyond theory into practice.

Kusi (2026) showed a progressive increase in green chemistry knowledge with the academic level of senior high school students. However, there was no significant difference by students' gender. The study also reported a weaker understanding of advanced green chemistry concepts. Mulyanti and Kadarohman (2021) revealed students' agreement with the principles of green chemistry, but some believed that their application in real life is practically not possible.

Da Silva Junior et al. (2024) argued that students are more capable of applying chemistry concepts when learning is linked to authentic environmental and community problems. Likewise, Sunay et al (2026) found that green chemistry instruction improved students' readiness to conserve resources, reduce waste and adopt safer chemical practices. These studies suggest that knowledge and application are intrinsically connected. Conceptual understanding provides the foundation for practice, while practical engagement reinforces knowledge.

Gender differences in green chemistry learning appear less pronounced than in some traditional STEM domains. Gunbatar et al. (2025) found that collaborative and real-world learning approaches supported participation across student groups. UNESCO (2024) further emphasised that many gender disparities in science arise from stereotypes and unequal opportunity rather than innate ability. Okunuga and Adeoye (2025) found no significant gender difference in students' awareness, knowledge or perception of green chemistry among Nigerian secondary school students. Male and female students showed similar levels of engagement. This suggests that when green chemistry is taught inclusively, male and female preservice teachers may perform similarly in both knowledge and application.

In contrast, the level of study tends to show a stronger influence. Students at

higher academic levels often possess a broader chemistry background, stronger reasoning abilities, and greater laboratory exposure. Gunbatar et al. (2025) noted that advanced earners generally achieved stronger outcomes in sustainability-related chemistry education. This indicates that progressive exposure over time enhances both understanding and application of chemistry concepts.

Preservice teachers are expected to possess adequate knowledge of green chemistry and the ability to apply its principles in laboratory work, teaching practice and everyday environmental decisions. However, studies suggest that many learners hold positive attitudes toward sustainability but lack a practical understanding of green chemistry (Gunbatar et al., 2025). It is necessary to determine whether knowledge of green chemistry significantly influences its applications to real-life situations. A student may know the principles in theory but fail to apply them in practice. Therefore, this investigation examines preservice teachers' knowledge and application of green chemistry principles while considering gender and level of study.

Statement of the Problem

Despite increasing global emphasis on sustainability, many teacher education programs still give limited attention to green chemistry. As a result, preservice teachers may graduate without sufficient knowledge or practical application skills in environmentally friendly chemistry.

It appears as if preservice teachers with greater knowledge of green chemistry are more likely to apply green chemistry principles or identify them. In addition, few studies examined the conceptual knowledge and application of green chemistry together using multiple-choice items. It seems as if the study on the influence of gender and level of study on both conceptual knowledge and application among preservice teachers is limited and examined green chemistry in the Nigerian context. These were the gaps this study investigated.

Purpose of the Study

The purpose of this study is to examine preservice teachers' conceptual knowledge of the principles and applications of green chemistry, and to determine the influence of gender and level of study on these variables and on possible misconceptions in green chemistry.

Specifically, the study seeks to:

1. Assess the levels of conceptual understanding and knowledge of applications of preservice teachers on the principles of green chemistry.
2. Find out if preservice teachers' conceptual understanding of the principles of green chemistry influences the applications of green chemistry to life situations.
3. Investigate the influence of preservice teachers' gender on the conceptual understanding of principles and applications to real-life situations of green chemistry.
4. Examine the influence of preservice teachers' level of study on the conceptual understanding of principles and applications to real-life situations of green chemistry.
5. Determine the interaction effect of gender and level of study on conceptual knowledge and application of green chemistry.

Research Question

1. What are the levels of conceptual understanding and knowledge of applications of preservice teachers on the principles of green chemistry?

Research Hypothesis

The following null hypotheses were postulated and tested at a 0.05 level of significance.

1. There is no significant relationship between preservice teachers' conceptual understanding of the principles of green chemistry and the applications of green chemistry to life situations.
2. Student gender does not significantly influence preservice teachers' conceptual understanding of principles and applications of green chemistry.
3. Levels of study do not significantly influence preservice teachers' conceptual understanding of principles and applications of green chemistry.
4. There is no significant interaction influence of gender and level of study on preservice teachers' conceptual understanding of principles and applications of green chemistry

Methodology

A descriptive survey design with a correlational component to assess levels of conceptual understanding of green chemistry and its applications, to determine

the relationship between conceptual understanding and application and to compare gender and level of study among the samples.

The population for the study was all preservice chemistry teachers at the university in Southwest Nigeria. Gender and level of study were selected by using stratified random sampling with the participants voluntarily participating in the study from three universities, with a total of three hundred and fifty-six (356) samples

The research instrument used for the study was a Preservice Teachers' Conceptual Understanding and Application of Green Chemistry Questionnaire (PTCUAGCQ) which composed of three sections: A, B, and C. Section A was the demographic information section, in which respondents were to provide their institutional name, gender, and level of study. Section B contained twenty-four (24) structured statements on the principles of green chemistry to elicit the respondents' concept of green chemistry. The respondents were to tick right (√) or mark wrong (X) as applicable to the principles. Section C had thirty-five (35) statements on the applications of green chemistry to real-life situations. The respondents were to either mark the statements as right or wrong. This format was adopted because the study conceptualised application as the ability to correctly identify environmentally responsible actions and reject inappropriate practices. Dichotomous scoring enabled objective assessment of respondents' practical understanding and decision-making competence in real-life situations.

Each correct answer attracted one (1) mark, while an incorrect answer was scored zero (0). The scoring range for level of conceptual understanding of the principles of green chemistry was 0-11, 12-16, and 17-24 as low, moderate and high, while the scoring for application level was 0-17, 18-24 and 25-35 as low, moderate and high, respectively.

The instrument was content- and construct-validated by three science educators. The inter-rater value for the validators was 0.82, based on Cohen's Kappa. The instrument was further subjected to pilot testing with 20 preservice teachers at a tertiary institution that was not sampled for the study. The reliability coefficient was .89 as measured by Kuder-Richardson Formula 20 (KR-20). The instrument was administered on 200, 300, and 400 levels preservice chemistry teachers sampled from the three universities in Southwestern Nigeria.

Data were analysed using descriptive statistics, including simple percentages, means, and standard deviations, to assess levels of conceptual understanding and the application of green chemistry. The levels were classified as high, moderate and low. Pearson's Product Moment Correlation, r, was used to determine if knowledge relates to application. Gender differences were determined on conceptual understanding and application using an independent samples t-test and one-way Analysis of Variances (ANOVA) to compare 200, 300, and 400 levels preservice chemistry teachers for both conceptual understanding and application, and a Post Hoc (Turkey) test was used to test for significant differences by levels of study. A two-way ANOVA was used to test the interaction effect of gender and level of study on the preservice chemistry teachers' conceptual understanding and application of green chemistry.

Results of Data Analysis

Table 1: Descriptive Statistics of Preservice Chemistry Teachers' Conceptual Understanding and Application of Principles of Green Chemistry

	Variable	N		Std. Error
Understanding Principles of Green Chemistry	Male	75	15.3200	2.92778	.33807
	Female	281	15.7260	3.74829	.22360
	Total	356	15.6404	3.59106	.19033
Application of Green Chemistry to real life	Male	75	20.3333	4.27227	.49332
	Female	281	21.0890	5.05073	.30130
	Total	356	20.9298	4.90106	.25976

Table 2: Correlation Values *of Preservice Chemistry Teachers' Conceptual Understanding and Application of Principles of Green Chemistry*

Variable		Understanding Principles of Green Chemistry	Application of Green Chemistry to real life
Understanding Principles of Green Chemistry	Pearson Correlation	1	.608**
	Sig. (2-tailed)		.000
	N	356	356
Application of Green Chemistry to real life	Pearson Correlation	.608**	1
	Sig. (2-tailed)	.000	
	N	356	356

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: The values of the Independent Samples T-Test on Preservice Chemistry Teachers' Gender on Conceptual Understanding and Application of Green Chemistry

		Levene's Test for Equality of Variances		t-test for Equality of Means						
Variables		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Conceptual Understand. Principles of Green Chemistry	Equal variances assumed	7.149	.008	-.870	354	.385	-.40598	.46689	-1.32420	.51225
	Equal variances not assumed			-1.002	145.545	.318	-.40598	.40533	-1.20707	.39511
Application of Green Chemistry to real life	Equal variances assumed	4.163	.042	-1.187	354	.236	-.75563	.63662	-2.00767	.49640
	Equal variances not assumed			-1.307	134.558	.193	-.75563	.57805	-1.89888	.38761

Table 4: One-Way ANOVA Values for Preservice Chemistry Teachers' Conceptual Understanding and Application of Principles of Green Chemistry by Level of Study

Variable		Sum of Squares	Df	Mean Square	F	Sig.
Understanding Principles of Green Chemistry	Between Groups	506.822	2	253.411	21.973	.000
	Within Groups	4071.156	353	11.533		
	Total	4577.978	355			
Application of Green Chemistry to real life	Between Groups	1081.402	2	540.701	25.634	.000
	Within Groups	7445.842	353	21.093		
	Total	8527.244	355			

Table 5: Post Hoc Tests of Multiple Comparisons for Preservice Chemistry Teachers' Conceptual Understanding and Application of Principles of Green Chemistry by Level of Study

Dependent Variable	(I) Level	(J) Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Understanding Principles of Green Chemistry	200.0	300.0	-1.55640*	.41696	.000	-2.3764	-.7364
		400.0	-2.99415*	.45790	.000	-3.8947	-2.0936
	300.0	200.0	1.55640*	.41696	.000	.7364	2.3764
		400.0	-1.43775*	.47260	.003	-2.3672	-.5083
	400.0	200.0	2.99415*	.45790	.000	2.0936	3.8947
		300.0	1.43775*	.47260	.003	.5083	2.3672
Application of GC to real life	200.0	300.0	-1.00288	.56389	.076	-2.1119	.1061
		400.0	-4.36088*	.61926	.000	-5.5788	-3.1430
	300.0	200.0	1.00288	.56389	.076	-.1061	2.1119
		400.0	-3.35800*	.63913	.000	-4.6150	-2.1010
	400.0	200.0	4.36088*	.61926	.000	3.1430	5.5788
		300.0	3.35800*	.63913	.000	2.1010	4.6150

Table 6: A Two-way ANOVA Values of Preservice Teachers' Gender and Level of Study on Conceptual Understanding of Principles of Green Chemistry

Dependent Variable: Understanding Principles of Green Chemistry

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	684.265[a]	5	136.853	12.302	.000	.149
Intercept	57129.542	1	57129.542	5135.289	.000	.936
Gender	43.589	1	43.589	3.918	.049	.011
Level	200.039	2	100.019	8.991	.000	.049
Gender * Level	133.616	2	66.808	6.005	.003	.033
Error	3893.712	350	11.125			
Total	91664.000	356				
Corrected Total	4577.978	355				

a. R Squared = .149 (Adjusted R Squared = .137)

Table 7: A Two-way ANOVA Values of Preservice Teachers' Gender and Level of Study on Applications of Principles of Green Chemistry

Dependent Variable: Application of GC to real life

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1757.388[a]	5	351.478	18.171	.000	.206
Intercept	102592.320	1	102592.320	5303.999	.000	.938
Gender	122.556	1	122.556	6.336	.012	.018
Level	349.350	2	174.675	9.031	.000	.049
Gender * Level	553.348	2	276.674	14.304	.000	.076
Error	6769.856	350	19.342			
Total	164475.000	356				
Corrected Total	8527.244	355				

a. R Squared = .206 (Adjusted R Squared = .195)

Answer to Research Question 1: 1. What are the levels of conceptual understanding and knowledge of applications of preservice teachers on the principles of green chemistry?

The mean score of the respondents in Table 1 on conceptual understanding was 15.64 (65.17%), which falls between the grading range of 12-16, indicating a moderate level of conceptual understanding of green chemistry. That is the preservice chemistry teachers had moderate knowledge of the principles of green chemistry. The mean score for the application of green chemistry principles was 20.93 (59.80%), indicating moderate knowledge of their application.

Testing of Hypotheses

Hypothesis 1: There is no significant relationship between preservice teachers' conceptual understanding of the principles of green chemistry and the applications of green chemistry to life situations.

Results from Table 2 of the correlation analysis indicate a correlation coefficient of $r = 0.608$, which is significant at $p = 0.000$ ($p < 0.05$) for conceptual understanding and application. The null hypothesis was rejected, and it was established that there is a significant relationship between preservice teachers' conceptual understanding of the principles of green chemistry and their applications in everyday life.

Hypothesis 2: Gender does not significantly influence preservice teachers' conceptual understanding of principles and applications of green chemistry.

The results of the independent samples t-test in Table 3 show Levene's Test of Variances for variance assumed means with p-values of 0.008 and 0.042 ($p < 0.05$), respectively, for conceptual understanding and application of green chemistry, indicating significant differences in the variables by gender. Hence, the equality of variances was not assumed, and the conclusion was $p = 0.318$ and $p = 0.193$ for conceptual understanding and application between male and female preservice chemistry teachers, indicating acceptance of the null hypothesis.

Hypothesis 3. Levels of study do not significantly influence preservice teachers' conceptual understanding of principles and applications of green chemistry.

Table 4's results of one-way ANOVA show significant differences among the preservice chemistry teachers by their study levels; $F_{(2,353)} = 21.973$, $p = 0.000$ ($p < 0.05$) for conceptual understanding and $F_{(2,353)} = 25.634$, $p = 0.000$ ($p < 0.05$) for application. Hence, the null hypothesis was rejected.

The post hoc test results in Table 5 show that 200-level preservice chemistry teachers' conceptual understanding differed significantly from that of 300-level and 400-level preservice teachers for both dependent variables. The 200-, 300-, and 400-level had mean scores of 14.35, 15.91, and 17.35, respectively, in conceptual understanding, while the 200-, 300-, and 400-level had mean scores of 19.49, 20.50, and 23.85, respectively, in the application of green chemistry.

Hypothesis 4: There is no significant interaction influence of gender and level of study on preservice teachers' conceptual understanding of principles and applications of green chemistry.

The results of the two-way ANOVA in Table 6 show a significant interaction between preservice chemistry teachers' gender and level of study on conceptual understanding, with $F_{(2,350)} = 6.005$, $p = 0.003$ ($p < 0.05$). Hence, the null hypothesis was rejected.

For the application of green chemistry, $F_{(2,350)} = 14.304$, $p = 0.000$ ($p < 0.05$), as shown in Table 7 of the two-way ANOVA. The null hypothesis 4 was also rejected.

Discussion of the Findings

This study examined preservice teachers' conceptual knowledge and application of green chemistry, as well as the influence of gender and level of study. The findings are discussed in relation to existing literature and relevant learning theories.

The finding that preservice teachers demonstrated moderate levels of both conceptual knowledge and application of green chemistry suggests that while some awareness exists, it is not sufficiently deep to support consistent practical implementation. This outcome reflects a persistent gap between theoretical exposure and functional understanding in sustainability education.

This finding aligns with Idul and Walag (2024), who reported that students often exhibit limited initial awareness of green chemistry when it is not explicitly embedded in the curriculum. Similarly, Gunbatar et al. (2025) observed that students' understanding tends to remain moderate when instruction relies heavily on

traditional, lecture-based approaches without adequate practical engagement. However, this finding contrasts with intervention-based studies such as Sunday et al. (2026), which reported higher levels of knowledge and environmental awareness among students exposed to structured green chemistry instruction. The discrepancy may be explained by differences in instructional approaches, as targeted interventions tend to produce stronger outcomes than conventional teaching methods.

From a theoretical perspective, constructivist theory suggests that learners develop a deeper understanding when knowledge is connected to real-life experiences (Vygotsky, 1978). The moderate performance observed may therefore reflect limited opportunities for contextualised learning. Similarly, experiential learning theory posits that knowledge becomes meaningful through active engagement and reflection (Kolb, 1984), which may be insufficient in traditional instructional settings.

The study found a significant positive relationship between conceptual knowledge and application, indicating that higher knowledge is associated with better application of green chemistry principles.

This finding is consistent with Idul et al. (2025), who reported that students who developed stronger conceptual understanding through inquiry-based approaches demonstrated improved ability to apply green chemistry in real-life contexts. Similarly, Sunday et al. (2026) found that increased knowledge of sustainability concepts was associated with more environmentally responsible practices. The result supports constructivist assumptions that meaningful understanding enhances application (Vygotsky, 1978) and aligns with experiential learning theory, which emphasises the role of experience in transforming knowledge into action (Kolb, 1984).

However, it is important to note that knowledge alone may not fully determine application. Factors like attitudes and values may influence it. This indicates that while knowledge is a critical predictor, it operates alongside other influencing variables.

The finding that gender did not significantly influence conceptual knowledge and application suggests that both male and female preservice teachers have comparable learning outcomes in green chemistry. This result aligns with Gunbatar et al. (2025), who reported that learner-centred and context-based instructional approaches tend to minimise gender disparities in science education.

However, this finding contrasts with earlier traditional STEM research, which often reported male advantages in science-related performance and participation (Hill et al., 2010; Organisation for Economic Cooperation and Development, OECD, 2015). These earlier disparities have been attributed largely to sociocultural influences, stereotypes, and differences in confidence rather than inherent ability.

Recent perspectives suggest that when learning environments are inclusive and opportunities are equal, gender differences tend to diminish (UNESCO, 2024). From a social learning perspective, equal exposure to role models and learning experiences can lead to similar outcomes across gender groups (Bandura, 1977). Thus, the absence of gender differences in this study may reflect improved equity in instructional practices and learning environments.

The study revealed that the level of study significantly influenced both conceptual knowledge and application, with higher-level students outperforming lower-level students (400 > 300 > 200), indicating the progression in the knowledge and application of green chemistry principles as students learn.

This finding is consistent with Gunbatar et al. (2025) and Kusi (2026), who noted that advanced students tend to demonstrate a stronger understanding of green chemistry due to cumulative academic exposure and laboratory experience. Similarly, Idul and Walag (2024) emphasised that prior knowledge significantly influences students' ability to understand and apply sustainability concepts. The result can be explained by Piaget's cognitive development and progressive learning, as higher-level students are more likely to engage in complex problem-solving and abstraction.

The finding of a significant interaction influence between gender and academic level suggests that the influence of academic level on knowledge and application varies across genders.

Although limited studies have directly examined this interaction in green chemistry, the finding is supported by broader educational research indicating that learning outcomes are shaped by

interactions among multiple variables, including learner characteristics and instructional context (Kolb, 1984; Bandura, 1977).

This result adds nuance to the earlier finding of no gender difference, suggesting that while gender alone may not be significant, its interaction with academic progression may influence learning patterns. This underscores the importance of adopting inclusive, adaptive teaching strategies that address the needs of diverse learners.

Conclusion

This study concludes that preservice teachers possess moderate levels of knowledge and application of green chemistry, indicating a need for stronger instructional support. The significant relationship between knowledge and application highlights the importance of conceptual understanding in promoting sustainable practices.

While gender does not significantly influence outcomes, the level of study plays a critical role, reflecting the impact of academic exposure and experience. The interaction effect further suggests that learning outcomes are shaped by multiple interconnected factors.

Overall, the study emphasises the need for curriculum reform and pedagogical innovation in teacher education to enhance sustainability competencies.

Recommendations

1. Green chemistry should be introduced early and progressively across all levels of teacher education.
2. Instruction should incorporate laboratory work, real-life case studies, and sustainability projects to enhance application.
3. Educators should be trained in modern, student-centred approaches to teaching green chemistry.
4. Institutions should model sustainable practices to reinforce learning through observation.
5. Teaching strategies should remain inclusive to sustain gender equity across all levels.
6. Future studies should explore additional variables such as environmental attitudes, teaching methods, and institutional culture.

Ethical Considerations: The researchers sought permission from the authorities of the sampled institutions before administering the questionnaire. None of the students was coerced into participating in the study

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AVAILABILITY, ACCESSIBILITY AND UTILISATION OF ASSISTIVE TECHNOLOGIES AMONG STUDENTS WITH SPECIAL NEEDS IN PUBLIC UNIVERSITIES IN SOUTHWEST NIGERIA

BY

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Abstract
This study investigated the availability, accessibility, and utilisation of Assistive Technologies among students with special needs in public universities in Southwest Nigeria. A descriptive survey design was adopted, with data collected from 312 respondents using a multistage sampling procedure. Data were collected by using a structured questionnaire (Assistive Technology Assessment Questionnaire (ATAQ), with a reliability coefficient of 0.87 when Cronbach's alpha was applied. Analysis involved descriptive statistics (mean, standard deviation) and inferential statistics (multiple regression and independent samples t-test) at 0.05 level of significance. Findings showed that Assistive Technologies were moderately available ($\bar{x}$ = 2.68, SD = 0.74) but poorly accessible ($\bar{x}$ = 2.41, SD = 0.81), while utilisation was moderate ($\bar{x}$ = 2.73, SD = 0.69). Finding also indicated that availability and accessibility significantly influenced Assistive Technology outcomes, highlighting the role of institutional factors in shaping usage. It was also found that there was no significant gender difference in utilisation ($t = 1.31$, $p > 0.05$). The study concludes that although Assistive Technologies are present, their effectiveness is limited by poor accessibility rather than availability alone.
Keywords: Assistive Technologies, accessibility, utilisation, special needs students, inclusive education

Introduction

The pursuit of inclusive education has gained significant global momentum, with increasing recognition of the need to provide equitable learning opportunities for students with special needs. Central to this effort is the integration of Assistive Technologies (AT), which encompass a wide range of devices, software applications, and adaptive systems designed to enhance the functional capabilities of individuals with disabilities. These technologies have been widely acknowledged as transformative tools that enable students to access instructional content, participate actively in learning processes, and achieve improved academic outcomes. Empirical evidence suggests that the effective deployment of Assistive Technologies contributes not only to academic success but also to increased autonomy, self-efficacy, and social inclusion among students with disabilities (UNESCO, 2023; World Health Organization, 2022; Dell, Newton, and Petroff, 2021). Despite these global advancements, disparities in the distribution and utilisation of Assistive Technologies remain evident, particularly in developing regions where structural and institutional constraints persist.

Across the African continent, the integration of Assistive Technologies into higher education systems continues to face multifaceted challenges. While policy frameworks supporting inclusive education have been adopted in several countries, their implementation has often been inconsistent and under-resourced. Studies have identified inadequate funding, poor technological infrastructure, and limited technical expertise as major barriers to the effective provision and utilisation of Assistive Technologies in African universities (Echezona and Echezona, 2020; Mtebe and Raisamo, 2021). In addition, sociocultural factors such as stigma, discrimination, and limited awareness of disability rights further exacerbate the exclusion of students with special needs. Evidence indicates that even in institutions where Assistive Technologies are available, their utilisation remains suboptimal due to insufficient training and lack of institutional support mechanisms (Chigona, 2022; Nkansah and Unwin, 2020). These conditions highlight the need for context-specific empirical investigations that address the realities of Assistive Technology integration in African higher education.

Within the West African sub-region, the challenges associated with Assistive Technology adoption are further intensified by systemic and policy-related limitations. Although several countries have ratified international conventions on disability inclusion and enacted national policies to support inclusive education, the translation of

these policies into actionable practices within universities remains limited. Research has shown that institutional frameworks for disability support are either weak or non-existent in many West African universities, resulting in inadequate provision and uneven distribution of Assistive Technologies (Ajuwon, 2020; Opini, 2021). Consequently, students with special needs often encounter significant barriers in accessing learning resources, which negatively impacts their academic participation and progression. The disconnect between policy formulation and practical implementation continues to undermine the effectiveness of inclusive education initiatives in the region.

In Nigeria, the discourse on inclusive education has received increasing attention, particularly following legislative efforts aimed at protecting the rights of persons with disabilities. Notwithstanding these developments, the situation within public universities reveals substantial gaps in the provision and utilisation of Assistive Technologies. Empirical studies have consistently reported inadequate availability of assistive devices, limited accessibility infrastructure, and insufficient technical support services within Nigerian higher education institutions (Okoli and Oyewumi, 2021; Aluko, 2022; Omede and Bakare, 2020). In many cases, the high cost of acquiring and maintaining Assistive Technologies, coupled with limited institutional funding, restricts their widespread adoption. Furthermore, a lack of awareness and training among both students and educators contributes to low utilisation levels, even when technologies are present. This disconnect between availability and actual usage underscores the complexity of factors influencing Assistive Technology integration in Nigerian universities.

In Southwest Nigeria, which represents one of the most educationally developed regions in the country, there is a growing emphasis on digital transformation and inclusive educational practices. Public universities in this region have made varying efforts to integrate technology into teaching and learning processes, including initiatives aimed at supporting students with special needs. However, evidence suggests that the extent of Assistive Technology provision and utilisation varies significantly across institutions, reflecting differences in funding, administrative commitment, and infrastructural capacity (Oladokun and Adebayo, 2023; Adeyemi and Olaleye, 2022). While some universities demonstrate moderate progress in the adoption of inclusive technologies, others continue to struggle with basic accessibility challenges. This uneven landscape creates disparities in learning opportunities for students with special needs and necessitates a systematic evaluation of the key factors influencing Assistive Technology deployment in the region.

The availability of Assistive Technologies constitutes a critical foundation for inclusive education, as it determines the extent to which institutions are equipped to support students with special needs. Availability reflects institutional priorities, policy implementation, and financial commitment to inclusive practices. Studies have shown that inadequate provision of Assistive Technologies limits students' ability to engage effectively with academic content, thereby hindering their overall educational experience (World Health Organization, 2022; Dell, Newton, and Petroff, 2021). In contexts where resources are scarce, availability becomes a major determinant of whether inclusive education can be meaningfully realised.

Accessibility represents another essential dimension, encompassing not only the presence of Assistive Technologies but also the conditions that enable students to use them effectively. Accessibility is influenced by a range of factors, including physical infrastructure, technical support services, institutional policies, and user competence. Research indicates that accessibility challenges often persist even in environments where technologies are available, due to barriers such as poor maintenance, lack of training, and limited awareness (Mtebe and Raisamo, 2021; Chigona, 2022). These challenges highlight the importance of examining accessibility as a distinct but interconnected component of Assistive Technology integration.

Utilisation reflects the extent to which students with special needs actively engage with Assistive Technologies in their academic activities. It is shaped by factors such as awareness, perceived usefulness, ease of use, and institutional support systems. Evidence suggests that utilisation patterns may vary across demographic variables, including gender, socio-economic background, and field of study (Nkansah and Unwin, 2020). In many cases, utilisation levels remain low despite the availability of technologies, indicating the presence of underlying barriers that limit effective adoption. Understanding these patterns is essential for designing interventions that promote sustained and meaningful use of Assistive Technologies.

The interrelationship among availability, accessibility, and utilisation provides a comprehensive framework for analysing the effectiveness of Assistive Technologies in

higher education. Availability ensures that resources are present, accessibility determines the extent to which these resources can be used, and utilisation reflects their actual impact on learning outcomes. The interaction of these factors ultimately shapes the educational experiences of students with special needs and influences their academic success. A holistic examination of these dimensions is therefore necessary to identify gaps and inform strategies for improving inclusive education practices.

Against this backdrop, this study assesses the availability, accessibility, and utilisation of Assistive Technologies among students with special needs in public universities in Southwest Nigeria. By providing empirical evidence on these critical dimensions, the study seeks to contribute to ongoing efforts aimed at enhancing inclusive education and promoting equitable access to learning opportunities for all students.

Objective of the Study

This study is designed to assess the availability, accessibility, and utilisation of Assistive Technologies among students with special needs in public universities in Southwest Nigeria, with specific objectives to:

(i) determine the availability of Assistive Technologies to students with special needs in public universities in Southwest Nigeria;
(ii) investigate the accessibility of students with special needs to Assistive Technologies in public universities in Southwest Nigeria; and
(iii) examine the utilisation of Assistive Technologies by students with special needs in public universities in Southwest Nigeria based on gender.

In line with the objectives of the study, the following research questions were raised:

(i) What is the level of availability of Assistive Technologies for students with special needs in public universities in Southwest Nigeria?
(ii) To what extent are Assistive Technologies accessible to students with special needs in public universities in Southwest Nigeria?
(iii) What is the level of utilisation of Assistive Technologies among students with special needs in public universities in Southwest Nigeria based on gender?

Based on the research questions and objectives of the study, the following null hypotheses were formulated and tested at 0.05 level of significance:

(i) The availability of Assistive Technology does not significantly predict inclusion of students with special needs in public universities in Southwest Nigeria
(ii) The accessibility of Assistive Technology does not significantly predict inclusion of students with special needs in public universities in Southwest Nigeria
(iii) There is no gender significant difference in the utilisation of Assistive Technologies by students with special needs in public universities in Southwest

Methodology

The study adopted a descriptive survey research design with a quantitative approach. This design was considered appropriate because it allows for the systematic collection of data from a defined population and enables the examination of relationships among variables as they exist in their natural setting without manipulation. The design also supports and describes the patterns relating to the availability, accessibility, and utilisation of Assistive Technologies among students with special needs.

The population for the study comprised all students with special needs in public universities in Southwest Nigeria. These universities were selected due to their concentration of higher education institutions and the presence of students with diverse disabilities. Three hundred and twelve (312) respondents comprising students with special needs and their facilitators were drawn using a multistage sampling procedure. In the first stage, public universities were stratified by state, and in the second stage, students with special needs were selected using purposive and proportionate sampling techniques to ensure adequate representation of different categories of disabilities.

Data for the study were collected using a structured questionnaire titled *Assistive Technology Assessment Questionnaire (ATAQ)*. The instrument was divided into sections covering demographic information, availability of Assistive Technologies, accessibility of Assistive Technologies, and utilisation of Assistive Technologies. Responses were measured on a four-point Likert scale ranging from Strongly Agree to Strongly Disagree. The instrument was validated through expert review in Measurement and Evaluation and Educational Technology, while reliability was established using Cronbach's Alpha coefficient, yielding a value of 0.87, indicating high internal consistency.

The study was guided by two empirical regression models aligned with the first two research objectives, while an independent

samples t-test was employed to examine gender differences in utilisation of Assistive Technologies among students with special needs..

The first model examined the availability of Assistive Technologies, expressed as:

$$ATAV = \beta_0 + \beta_1 AVA + \mu$$

This model was used to determine the extent to which Assistive Technologies are available to students with special needs. The dependent variable (ATAV) represents the overall availability index, while AVA captures specific indicators of availability within the institutions. The model enables the study to quantify the level of provision of Assistive Technologies and assess whether availability is adequate within the study context.

The second model assessed the accessibility of Assistive Technologies, specified as:

$$ATAC = \beta_0 + \beta_1 ACC + \mu$$

This model determined how accessibility factors influence the extent to which Assistive Technologies are usable and reachable by students with special needs.

To complement the regression analyses, an independent samples t-test was used to determine whether there is a significant difference in the utilisation of Assistive Technologies between male and female students with special needs. This was considered appropriate because the variable of interest (gender) is categorical, while utilisation is continuous.

Together, these analytical techniques provide a comprehensive framework for examining availability, accessibility, and gender-based differences in utilisation of Assistive Technologies in the study context

Data collected were analysed using both descriptive and inferential statistics. Mean and standard deviation were used to answer the research questions, while independent samples t-test and multiple regression analysis were employed to test the hypotheses at 0.05 level of significance. The regression analysis was particularly used to determine the extent to which availability and accessibility predict utilisation of Assistive Technologies, as well as the influence of gender on utilisation patterns.

Ethical considerations were observed throughout the study. Participation was voluntary, and respondents were assured of confidentiality and anonymity. Consent was obtained from participants before data collection, and the study adhered to ethical standards governing research involving human participants in educational settings.

Research Question One

What is the level of availability of Assistive Technologies for students with special needs in public universities in Southwest Nigeria?

Table 1: Mean Responses on Availability of Assistive Technologies

Item	N	Mean (x̄)	SD	Remark
Availability of screen readers	312	2.71	0.76	Moderate
Availability of Braille devices	312	2.54	0.81	Moderate
Availability of hearing assistive devices	312	2.79	0.72	Moderate
Availability of adaptive learning software	312	2.69	0.69	Moderate
Cluster Mean		**2.68**	**0.74**	**Moderate**

Table one showed the cluster mean score of 2.68 which indicates that Assistive Technologies are moderately available in public universities in Southwest Nigeria. However, the distribution of responses across items reveals noticeable inconsistencies. While hearing assistive devices recorded the highest mean (2.79), suggesting relatively better availability, Braille devices recorded the lowest mean (2.54), indicating limited provision for visually impaired students.

The standard deviation values (0.69–0.81) further indicate variability in responses, suggesting that availability is not uniform across institutions or categories of Assistive Technologies. This implies that some universities may have more developed assistive infrastructure than others, creating inequality in access to learning support tools. This implies that although Assistive Technologies exist within the university system, their partial and uneven availability limits their effectiveness in ensuring full inclusion. This creates a structural imbalance where students' learning support depends heavily on institutional capacity rather than standardized provision.

Research Question Two

To what extent are Assistive Technologies accessible to students with special needs in public universities in Southwest Nigeria?

Table 2: Mean Responses on Accessibility of Assistive Technologies

Item	N	Mean (x̄)	SD	Remark
Ease of accessing AT devices	312	2.38	0.83	Low
Availability in learning environments	312	2.45	0.79	Low
Technical support for AT usage	312	2.36	0.82	Low
Ease of obtaining AT when needed	312	2.45	0.78	Low
Cluster Mean		**2.41**	**0.81**	**Low**

Table 2 showed the cluster mean of 2.41 which clearly indicates that Assistive Technologies are poorly accessible to students with special needs. All item means fall below the decision benchmark, suggesting systemic accessibility challenges.

The lowest mean (2.36) relates to technical support, indicating that even when devices are available, students lack adequate institutional assistance for effective usage. The relatively consistent standard deviation values suggest that poor accessibility is a widespread condition across respondents rather than an isolated institutional issue. This result implies that accessibility barriers rather than mere availability constitute a major limitation to inclusive education. Even where Assistive Technologies exist, structural constraints such as poor support systems, inadequate deployment strategies, and limited integration into learning environments significantly reduce their usability.

Research Question Three

What is the level of utilisation of Assistive Technologies among students with special needs based on gender?

Table 3: Mean responses on Utilisation of Assistive Technologies by Gender

Gender	N	Mean (x̄)	SD
Male	148	2.76	0.70
Female	164	2.70	0.68
Cluster Mean	312	**2.73**	**0.69**

Table 3 showed the cluster mean of 2.73 which is an indication of a moderate level of utilisation of Assistive Technologies among students with special needs. The slight difference between male (2.76) and female (2.70) respondents suggests a marginal variation in usage patterns, with male students reporting slightly higher utilisation.

However, the closeness of the mean scores indicates that gender differences in utilisation are minimal at the descriptive level. This necessitates inferential testing to determine whether the observed difference is statistically significant. The implication of this is that, while utilisation is moderate, it does not reflect optimal engagement with Assistive Technologies. The findings suggest that usage is influenced more by institutional and environmental factors than by gender alone.

TEST OF HYPOTHESES

Hypothesis One

The availability of Assistive Technology does not significantly predict inclusion of students with special needs in public universities in Southwest Nigeria.

Table 4: Regression Analysis for Availability Model

Estimated Regression Equation

$$ATAV = 1.12 + 0.52AVA$$

Model	R	R^2	Adjusted R^2	F	Sig.
1	0.58	0.34	0.33	82.45	0.000

The regression result shows a correlation coefficient (R) of 0.58, indicating a moderate positive relationship between availability and Assistive Technology presence in universities.

The coefficient of determination ($R^2 = 0.34$) implies that approximately 34% of the variation in Assistive Technology availability is explained by availability-related factors captured in the model.

Substituting the estimated coefficients into the regression equation shows that a one-unit increase in availability (AVA) leads to a 0.52 increase in Assistive Technology availability index (ATAV). This indicates a positive and

meaningful contribution of availability to the outcome variable.

The constant term (β_0 = 1.12) represents the baseline level of Assistive Technology availability when AVA is zero. The F-statistic (82.45) is statistically significant at $p < 0.05$, indicating that the model is a good fit. Therefore, availability is a statistically significant predictor within the study context.

Hypothesis Two

The accessibility of Assistive Technology does not significantly predict inclusion of students with special needs in public universities in Southwest Nigeria.

Table 5: Regression Analysis for Accessibility Model

ATAC=1.08+0.57ACC

Model	R	R^2	Adjusted R^2	F	Sig.
1	0.62	0.38	0.37	96.18	0.000

The regression result revels an R value of 0.62, indicating a moderately strong relationship between accessibility-related factors and Assistive Technology access. The R^2 value 0.38 shows that 38% of the variation in accessibility is explained by institutional and infrastructural factors included in the model. The F-value (91.12) is statistically significant, confirming that accessibility is not random but shaped by measurable institutional conditions. Therefore, the null hypothesis is rejected. This implies that accessibility remains a major structural challenge in universities, and improvements in infrastructure and support systems are necessary to enhance effective use of Assistive Technologies

Substituting the estimated coefficients into the regression equation indicates that a one-unit increase in accessibility (ACC) leads to a 0.57 increase in Assistive Technology accessibility index (ATAC). This reflects a strong positive contribution of accessibility to the outcome variable.

The constant term (β_0 = 1.08) represents the baseline level of Assistive Technology accessibility when ACC is zero.

The F-statistic (96.18) is statistically significant at $p < 0.05$, indicating that the model is a good fit. Therefore, accessibility is a statistically significant predictor of Assistive Technology accessibility within the study context.

Hypothesis Three

There is no gender significant difference in the utilisation of Assistive Technologies by students with special needs in public universities in Southwest

Table 6: Independent Samples t-test on utilisation of Assistive Technologies based on gender

Gender	N	Mean	SD	T	Df	P
Male	148	2.76	0.70	1.31	310	0.191
Female	164	2.70	0.68			

The t-test result shows a calculated t-value of 1.31 with a p-value of 0.191, which is greater than the 0.05 significance level. This indicates that there is no statistically significant difference in the utilisation of Assistive Technologies between male and female students with special needs. Although males recorded a slightly higher mean score, the difference is not strong enough to be considered statistically meaningful. The null hypothesis is retained. This implies that gender does not significantly influence utilisation patterns, suggesting that other factors such as accessibility, awareness, and institutional support are more critical determinants of Assistive Technology usage.

Discussion of Findings

The finding showed that Assistive Technologies are significantly available in public universities in Southwest Nigeria ($R = 0.58$, $R^2 = 0.34$, $F(1,310) = 82.45$, $p = 0.000$), with a moderate mean ($\bar{x} = 2.68$). This supports Dell, Newton, and Petroff (2021) and UNESCO (2023), which reported increasing provision of assistive tools, but contrasts with Okoli and Oyewumi (2021), who found low availability in Nigerian universities. The variation suggests uneven institutional improvements across the region.

The finding also revealed that accessibility is significantly low despite its statistical influence ($R = 0.61$, $R^2 = 0.37$, $F(1,310) = 91.12$, $p = 0.000$), with a low mean ($\bar{x} = 2.41$). This aligns with Mtebe and Raisamo (2021)

and Chigona (2022), who identified infrastructure and institutional readiness as key barriers, but contrasts with Nkansah and Unwin (2020), who reported better accessibility in more structured contexts. This confirms that accessibility is highly dependent on institutional capacity.

The finding indicated no significant gender difference in utilisation ($t(310) = 1.31$, $p > 0.05$), although utilisation was moderate ($\bar{x} = 2.73$). This supports Adeyemi and Olaleye (2022) and Nkansah and Unwin (2020), suggesting that institutional conditions, rather than gender, determine usage.

Overall, the findings reveal a consistent pattern: Assistive Technologies are moderately available and utilised but poorly accessible, indicating a disconnect between provision and effective use. Regression results ($R^2 = 0.34–0.37$) confirm the strong influence of institutional factors. The study supports Dell et al. (2021) that accessibility and usability—not mere provision—drive inclusive education outcomes, while challenging Ajuwon (2020) by showing that policy presence alone is insufficient without effective implementation. Accessibility therefore emerges as the critical link between availability and utilisation.

Conclusion

The study concludes that Assistive Technologies are present in public universities in Southwest Nigeria but unevenly distributed, reflecting partial institutional commitment. Accessibility remains a major constraint, limiting effective use despite availability. Utilisation is moderate, indicating suboptimal engagement, while gender has no significant influence, suggesting that usage depends more on institutional conditions than demographic factors.

Overall, the effectiveness of Assistive Technologies is constrained more by accessibility and implementation challenges than by availability, highlighting the need for stronger institutional support systems.

Recommendations

Based on the study findings, the following recommendations are made:

(i) Public universities should increase targeted funding to improve the provision of Assistive Technologies across faculties.
(ii) Institutions should prioritise accessibility by ensuring proper installation, maintenance, and strategic placement of assistive tools within learning environments.
(iii) Regular training and technical support programmes should be implemented to enhance effective utilisation among students.
(iv) Lecturers should be trained in inclusive teaching practices and integration of Assistive Technologies into instruction.
(v) Disability support units should establish monitoring systems to track utilisation and identify gaps.
(vi) Government and regulatory bodies should enforce minimum standards for Assistive Technology provision and accessibility.
(vii) Collaboration with NGOs and development partners should be strengthened to support funding, infrastructure, and sustainability.

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UTILISATION OF ONLINE TEACHING PLATFORMS AND ASSOCIATED CHALLENGES AMONG UNIVERSITY LECTURERS IN SOUTHWEST NIGERIA

BY

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Abstract

This study examined the utilisation of online teaching platforms and associated challenges among university lecturers in Southwest Nigeria, with emphasis on the influence of ICT competence, institutional support, and infrastructural constraints. A descriptive survey research design was adopted. The population comprised lecturers in selected public universities in Southwest Nigeria, from which 312 respondents were selected using a multistage sampling technique. Data were collected using a structured questionnaire validated by experts and with a reliability coefficient of 0.87. Data were analysed using descriptive statistics and multiple regression analysis. Findings revealed a moderate level of utilisation of online teaching platforms (M = 2.84). Key challenges included unstable electricity supply (M = 2.10), high cost of internet data (M = 2.32), and poor network connectivity (M = 2.28). The regression result showed that ICT competence (β = 0.41, p < 0.05) and institutional support (β = 0.33, p < 0.05) significantly and positively influenced utilisation, while infrastructural constraints had a significant negative effect (β = -0.29, p < 0.05). The study concluded that utilisation of online teaching platforms is jointly shaped by individual, institutional, and infrastructural factors.

Keywords: Online teaching platforms, utilisation, ICT competence, institutional support, infrastructural challenges.

Introduction

The rapid advancement of information and communication technology (ICT) has brought about significant transformation in the global higher education system. One of the most notable developments in this transformation is the emergence of online teaching platforms, which have redefined the traditional approaches to teaching and learning. Platforms such as Zoom, Google Classroom, Microsoft Teams, Moodle, and WhatsApp now play a central role in facilitating instructional delivery, academic communication, assessment, and collaborative learning in universities across the world. These platforms have enabled education to extend beyond the physical classroom, thereby promoting flexibility, accessibility, and continuity in academic engagement.

In developed educational systems, online teaching platforms are fully integrated into university teaching practices, supported by strong digital infrastructure, institutional policies, and continuous capacity-building programmes for academic staff (Adeyeye et al., 2022). However, in many developing countries, including Nigeria, the level of utilisation remains inconsistent due to infrastructural constraints and varying levels of ICT competence among lecturers. In Southwest Nigeria, which hosts a large concentration of federal and state universities, efforts have been made to incorporate digital teaching tools into academic delivery systems, (Omojemite, 2024). Akinsanya, (2025), opines that despite these efforts, evidence suggests that the extent of utilisation among lecturers differs significantly across institutions and individuals. It is therefore important to examine the level of utilisation of online teaching platforms among university lecturers in Southwest Nigeria, in order to determine how extensively these tools are being integrated into instructional practices.

Beyond the general level of utilisation, understanding the specific platforms commonly used by lecturers is essential for evaluating the digital teaching landscape in higher education. While several online teaching tools are available globally, their adoption within Nigerian universities is often influenced by familiarity, accessibility, institutional preference, and ease of use. Some platforms may be more dominant than others due to their simplicity or institutional support, (Okon, et al., 2024). Therefore, this study also seeks to identify the online teaching platforms commonly used by university lecturers in Southwest Nigeria, with a view to understanding usage patterns and platform preference in academic delivery.

In addition to identifying commonly used platforms, it is equally important to examine the purposes for which lecturers utilise online teaching platforms. These platforms are not

limited to delivering lectures alone but are also used for uploading course materials, conducting assessments, holding virtual meetings, and maintaining communication with students. According to Akinsanya (2025), the effectiveness of these platforms largely depends on the extent to which they are purposefully integrated into teaching and learning activities. As such, this study further investigates the purposes of utilisation of online teaching platforms among university lecturers in Southwest Nigeria, to better understand how these tools are applied in academic settings.

Despite the growing adoption of online teaching platforms in Nigerian universities, several challenges continue to hinder their effective utilisation. These challenges include poor internet connectivity, unstable electricity supply, high cost of data subscription, inadequate ICT skills among lecturers, and insufficient institutional support (Yakmut, 2025; Tijani, 2024,). These constraints not only affect access to digital tools but also influence the consistency and quality of their usage in teaching and learning processes. Consequently, this study examines the challenges affecting the utilisation of online teaching platforms among university lecturers in Southwest Nigeria, with the aim of identifying the key barriers to effective digital teaching.

Furthermore, the successful utilisation of online teaching platforms is strongly influenced by lecturers' ICT skills, which determine their ability to effectively navigate and integrate digital tools into instructional practices. Oyadeyi (2025) believes that lecturers with higher levels of ICT competence are more likely to adopt and sustain the use of online teaching platforms, while those with limited skills may struggle with their application. This highlights the importance of digital literacy in shaping teaching practices in modern higher education. Therefore, this study also examines the relationship between ICT skills and utilisation of online teaching platforms among university lecturers in Southwest Nigeria, in order to determine how digital competence influences usage behaviour.

Overall, while online teaching platforms have become an essential component of contemporary higher education, their effective utilisation in Southwest Nigerian universities remains a subject of concern due to varying levels of adoption, usage patterns, and persistent challenges. This study therefore seeks to provide empirical evidence on utilisation levels, platform usage patterns, purposes of use, associated challenges, and the influence of ICT skills among university lecturers in the region.

Statement of the Problem

Despite the increasing adoption of online teaching platforms in Nigerian universities, their utilisation among lecturers in Southwest Nigeria remains inconsistent and often suboptimal. While some lecturers actively integrate digital platforms into teaching, others make limited or irregular use due to challenges such as inadequate ICT skills, poor internet connectivity, unstable electricity supply, high cost of data, and insufficient institutional support. These constraints continue to affect the effectiveness of digital teaching practices in higher education. However, existing studies have not sufficiently provided integrated empirical evidence on utilisation patterns, usage purposes, and associated challenges among university lecturers in Southwest Nigeria. This study therefore investigates these factors to provide comprehensive insights for improving the effective use of online teaching platforms in universities.

Objectives of the Study

The main objective of this study is to examine the utilisation of online teaching platforms and the associated challenges among university lecturers in Southwest Nigeria.

The specific objectives are to:

1. determine the level of utilisation of online teaching platforms among university lecturers in Southwest Nigeria;
2. identify the commonly used online teaching platforms among lecturers;
3. examine the challenges affecting the utilisation of online teaching platforms among lecturers;
4. determine the joint and relative influence of ICT competence, institutional support, and infrastructural challenges on utilisation of online teaching platforms;
5. examine whether there is a significant difference in utilisation of online teaching platforms across selected universities in Southwest Nigeria.

Research Questions

The following research questions guided the study:

1. What is the level of utilisation of online teaching platforms among

university lecturers in Southwest Nigeria?
2. What are the commonly used online teaching platforms among lecturers?
3. What challenges affect utilisation of online teaching platforms among lecturers?

Research Hypotheses

The following research hypotheses were formulated for the study:

1. There is no significant joint influence between ICT competence, institutional support, and infrastructural challenges on utilisation of online teaching platforms
2. There is no significant difference in utilization of online teaching across selected universities in Southwest Nigeria

Methodology

This study adopted a descriptive survey research design. The design was considered appropriate because it enables the systematic collection of data from a large sample of respondents and allows the researcher to describe existing conditions, patterns, and relationships among variables as they naturally occur without manipulation. The population of the study comprised all lecturers in selected public universities in Southwest Nigeria, specifically drawn from Ogun, Oyo, and Lagos States. These states were selected because they host some of the most established and technologically advanced universities in Nigeria, where online teaching platforms are increasingly integrated into instructional delivery.

The universities included in the study are: University of Lagos, Lagos State University, University of Ibadan, Ladoke Akintola University of Technology, Olabisi Onabanjo University, Federal University of Agriculture, Abeokuta. These institutions represent a mix of federal and state universities, thereby ensuring institutional diversity in terms of funding structure, ICT development, and administrative policies. The estimated population of lecturers across these institutions is approximately 5,800 academic staff, comprising different academic ranks and disciplinary backgrounds.

A total of 312 lecturers were selected as the sample for the study. This sample size was considered adequate for statistical generalisation and inferential analysis. A multistage sampling technique was employed. In the first stage, three states (Lagos, Oyo, and Ogun) were selected using simple random sampling. In the second stage, two universities were purposively selected from each state based on institutional size, academic reputation, and evidence of ICT integration in teaching. In the third stage, stratified random sampling was used to select lecturers across faculties and academic ranks to ensure proportional representation. This ensured that respondents reflected the diversity of academic staff across disciplines and institutional types.

Data were collected using a structured questionnaire titled Utilisation and Challenges of Online Teaching Platforms Questionnaire (UCTPQ). The instrument consisted of five sections: Section A is the demographic characteristics of respondents; Section B is about the level of utilisation of online teaching platforms; Section C is about commonly used online teaching platforms; section D is about purposes of utilisation of online teaching platforms while section E deals with ICT competence, institutional support, and infrastructural challenges. All sections except Section A were measured using a 4-point Likert scale of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1).

The instrument was subjected to face and content validity by experts in Educational Technology and Measurement and Evaluation. The experts assessed the relevance, clarity, and adequacy of the items in relation to the research objectives. Their constructive feedback led to refinement, modification, and restructuring of certain items to improve clarity and ensure comprehensive coverage of all variables under investigation.

The reliability of the instrument was established using Cronbach's Alpha method. A pilot study was conducted on lecturers from institutions outside the study area but with similar characteristics to the target population. The instrument yielded a reliability coefficient of 0.86, indicating high internal consistency and suitability for data collection.

The questionnaire was administered both physically and electronically to enhance coverage and improve response rate. Respondents were given clear instructions and assured of confidentiality to encourage honest responses. Follow-up visits and reminders were made to improve retrieval rate, which was satisfactory for analysis.

Data Analysis and Presentation

Data collected were analysed using both descriptive and inferential statistics. Frequency counts, percentages, mean, and standard deviation were used to answer the research questions, while the hypotheses were tested using Inferential Statistics Pearson's Product Moment Correlation (PPMC), Multiple

Regression Analysis and One-way Analysis of Variance (ANOVA).

A benchmark mean of 2.50 was adopted for decision-making:

- Mean ≥ 2.50 = High utilisation / Positive response / Agree
- Mean < 2.50 = Low utilisation / Negative response / Disagree

Research Question 1

What is the level of utilisation of online teaching platforms among university lecturers in Southwest Nigeria?

Table 1: Mean and standard deviation on the Level of Utilisation of Online Teaching Platforms

S/N	Items	Mean	SD	Decision
1	I use Zoom for teaching delivery	3.48	0.72	High
2	I use Google Classroom for instruction	3.21	0.80	High
3	I use Microsoft Teams for lectures	3.05	0.83	High
4	I use Moodle LMS for teaching	2.87	0.85	Moderate
5	I use WhatsApp for academic communication	3.62	0.60	High
6	I upload lecture materials online	2.94	0.79	Moderate
7	I conduct live online classes	3.10	0.77	High
8	I use online platforms for assessments	2.76	0.88	Moderate
9	I record lectures for online use	2.58	0.91	Moderate
10	I fully integrate online platforms in teaching	2.69	0.86	Moderate

Cluster Mean = 3.03

The result shows that the utilisation of online teaching platforms among lecturers in Southwest Nigeria is moderate to high, with a cluster mean of 3.03, which is above the benchmark of 2.50. Item analysis reveals that WhatsApp (M = 3.62) and Zoom (M = 3.48) are the most frequently used platforms. This indicates that lecturers prefer platforms that are simple, accessible, and cost-effective. However, utilisation of structured learning systems such as Moodle and advanced features like recorded lectures remains moderate, suggesting that utilisation is still largely basic and communication-driven rather than fully integrated instructional usage.

Research Question 2

What are the commonly used online teaching platforms among lecturers?

Table 2: Mean and standard deviation on the Commonly Used Online Teaching Platforms

S/N	Platform	Mean	SD	Rank
1	WhatsApp	3.70	0.55	1st
2	Zoom	3.45	0.68	2nd
3	Google Classroom	3.20	0.74	3rd
4	Microsoft Teams	3.02	0.81	4th
5	Moodle LMS	2.85	0.86	5th
6	Telegram	2.60	0.90	6th

The result indicates that WhatsApp is the most commonly used online teaching platform, followed by Zoom and Google Classroom. This suggests that lecturers strongly prefer platforms that are familiar, easy to operate, and less data-demanding. The dominance of WhatsApp reflects the strong influence of informal communication tools in academic activities. Lower usage of LMS platforms such as Moodle indicates limited adoption of structured digital learning environments in Nigerian universities.

Research Question 3

What are the challenges affecting utilisation of online teaching platforms?

Table 3: Mean and standard deviation on the Challenges Affecting Utilisation

S/N	Items	Mean	SD	Decision
1	Unstable electricity supply	1.92	0.88	Severe
2	High cost of internet data	2.10	0.84	Severe
3	Poor internet connectivity	2.05	0.86	Severe
4	Lack of ICT support	2.48	0.80	Moderate
5	Inadequate training	2.42	0.83	Moderate
6	Lack of digital devices	2.55	0.78	Moderate
7	Technical difficulties	2.38	0.85	Moderate
8	Limited time for preparation	2.60	0.77	Moderate
9	Poor student engagement	2.44	0.82	Moderate
10	Lack of motivation	2.30	0.89	Moderate

Cluster Mean = 2.31

The result shows that lecturers experience a moderate to severe level of challenges, with a cluster mean of 2.31, which is below the benchmark of 2.50. Major challenges include unstable electricity supply, poor internet connectivity, and high cost of data. These indicate that infrastructural problems are the most serious barriers to utilisation. Moderate challenges such as lack of training and ICT support show that institutional support is also inadequate.

Research Hypothesis 1

There is no significant joint influence between ICT competence, institutional support, and infrastructural challenges on utilisation of online teaching platforms

Table 4: Multiple Regression Analysis on ICT competence, institutional support, and infrastructural challenges on utilisation

Model	R	R^2	Adj. R^2	F	Sig.
	0.74	0.55	0.54	124.38	0.000

Variables	B	Beta	t	Sig.
Constant	1.214	—	3.89	0.000
ICT Competence	0.421	0.395	6.19	0.000
Institutional Support	0.318	0.281	4.42	0.000
Infrastructural Challenges	-0.276	-0.263	-4.52	0.000

The regression results show that ICT competence, institutional support, and infrastructural challenges jointly explain 55% of variation in utilisation. ICT competence is the strongest predictor, followed by institutional support. Infrastructural challenges negatively affect utilisation. The model is statistically significant ($p < 0.05$), indicating strong explanatory power.

Research Hypothesis 2

There is no significant difference in utilization of online teaching across selected universities in Southwest Nigeria

Table 5: ANOVA Result on utilisation across universities

Source	SS	Df	MS	F	Sig.
Between Groups	18.742	5	3.748	6.92	0.000
Within Groups	165.381	306	0.540		
Total	184.123	311			

The result shows a significant difference in utilisation across universities ($F = 6.92$, $p = 0.000$).

This implies that institutional environment influences lecturers' adoption of online teaching platforms.

Discussion of Findings

The study found that the utilisation of online teaching platforms among university lecturers in Southwest Nigeria is moderate to high. This indicates that lecturers are actively engaged in the use of digital tools such as WhatsApp, Zoom, and Google Classroom, although utilisation of structured learning

management systems remains limited. This is in line with the findings of Oyadeyi (2025), Akinsanya (2025) and Dhawan (2020), who reported that online platforms became widely adopted in higher education due to their flexibility, especially during and after the COVID-19 pandemic. However, this finding contrasts with Okoye et al. (2021), who observed low utilisation of e-learning platforms among lecturers in some Nigerian universities due to infrastructural and technical constraints. The difference may be explained by increased digital exposure and institutional adaptation after the pandemic period. From the researcher's perspective, utilisation in Southwest Nigeria reflects a transition phase, where lecturers have moved beyond non-use but have not yet achieved full integration of online teaching into structured academic delivery.

The study revealed that WhatsApp, Zoom, and Google Classroom are the most commonly used platforms among lecturers, while LMS platforms such as Moodle are less frequently used. This shows a strong preference for simple, familiar, and low-data platforms. This finding is supported by Afolabi et al. (2021), who reported that WhatsApp is widely used among Nigerian lecturers due to its accessibility, familiarity, and low cost. Dhawan (2020) also noted that Zoom gained global popularity because of its simplicity and real-time communication features. In contrast, Aristovnik et al. (2020) argued that in more developed educational systems, structured LMS platforms dominate online teaching due to institutional enforcement and better infrastructure. This contrast highlights the digital divide between developed and developing contexts. From the researcher's viewpoint, platform selection in Southwest Nigeria is driven more by practical survival needs (cost, ease, access) than by pedagogical design or institutional policy.

The study identified unstable electricity supply, high internet costs, and poor connectivity as major challenges affecting utilisation of online teaching platforms. These were rated as severe barriers. This finding is strongly supported by Yakmut (2025), Tijani (2024,) and Adedoyin & Soykan (2020), who identified infrastructural deficiencies as major constraints to online learning in developing countries. Okoye et al. (2021) also reported that electricity instability and high data costs significantly hinder effective e-learning adoption in Nigerian universities. From the researcher's perspective, these challenges indicate that the problem is not lack of willingness among lecturers but rather systemic infrastructural inadequacy, which continues to limit digital transformation in higher education.

The study found that ICT competence, institutional support, and infrastructural challenges jointly influence utilisation of online teaching platforms, with ICT competence being the strongest positive predictor. This finding is supported by Okon et al., (2024) and Almaiah et al. (2020), who emphasized that successful e-learning adoption depends on user skills, institutional readiness, and infrastructure. However, some studies place stronger emphasis on infrastructure alone as the dominant factor in developing countries, suggesting a more unidimensional explanation. This study expands that view by showing that multiple interacting factors are responsible for utilisation behaviour. From the researcher's perspective, utilisation is best explained as a multi-factor behavioural outcome, where human capacity, institutional systems, and environmental conditions interact simultaneously.

The study found significant differences in utilisation of online teaching platforms across universities in Southwest Nigeria. This indicates that institutional environment strongly influences lecturers' engagement with digital teaching tools. This finding is supported by Aristovnik et al. (2020), who reported that institutional disparities significantly affect digital learning adoption due to differences in infrastructure and policy support. However, this contrasts with studies suggesting uniform adoption patterns in well-standardized educational systems, where institutional differences are minimal (Akinsanya, 2025). From the researcher's perspective, the observed differences reflect unequal ICT development across universities, leading to fragmented digital teaching adoption in the region.

Conclusion

This study examined the utilisation of online teaching platforms and associated challenges among university lecturers in Southwest Nigeria. The findings revealed that lecturers demonstrate a moderate to high level of utilisation of online teaching platforms, indicating that digital tools have become an important component of instructional delivery in higher education.

The study also established that WhatsApp, Zoom, and Google Classroom are the most commonly used platforms, largely due to their accessibility, simplicity, and low data requirements. However, utilisation of structured learning management systems remains limited, suggesting that digital teaching is still largely informal and communication-based rather than fully

integrated into academic systems. Furthermore, the study identified significant challenges affecting utilisation, particularly unstable electricity supply, high cost of internet data, and poor network connectivity. These infrastructural constraints were found to significantly limit effective engagement with online teaching platforms.

The study concluded that utilisation of online teaching platforms among lecturers is influenced by a combination of individual capacity, institutional support, and infrastructural conditions. It also established significant differences in utilisation across universities, indicating that institutional environment plays a critical role in shaping digital teaching practices. Overall, while there is clear progress in the adoption of online teaching platforms, full integration into teaching practice remains constrained by systemic and environmental challenges.

Recommendations

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

1. Universities should organise continuous ICT training programmes to enhance lecturers' digital competence and improve effective utilisation of online teaching platforms.
2. Universities should provide subsidised internet access or data support schemes to reduce the financial burden on lecturers and encourage sustained usage of online platforms
3. Government and institutional authorities should invest in stable electricity supply and reliable internet infrastructure to support seamless digital teaching activities.
4. Institutional ICT units should be strengthened to provide prompt technical support and troubleshooting services during online teaching sessions.
5. Universities should adopt structured Learning Management Systems (LMS) and integrate them into official teaching policies to move beyond informal tools such as WhatsApp.
6. Institutional policies should be harmonised across universities in Southwest Nigeria to reduce disparities in ICT adoption and ensure more uniform utilisation of online teaching platforms.

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EFFECTS OF PROBLEM-BASED LEARNING (PBL) ON STUDENTS' PHYSICS ACHIEVEMENT AND KNOWLEDGE ECONOMY SKILLS

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Abstract
This study investigated the effects of Problem-Based Learning (PBL) on students' Physics achievement and knowledge economy skills. Two research questions and two hypotheses guided the study. The sample size consisted of 194 SS II Physics students who were randomly drawn from four coeducation in Imo State. Data were collected using a Physics Achievement Test (PAT) and a Knowledge Economy Skills Questionnaire (KESQ), covering problem-solving, critical thinking, collaboration, creativity, and digital literacy. Mean and standard deviation were used to answer the two research questions, while t-test was employed to test the non-hypotheses at 0.05 level of significance. The results revealed that students exposed to PBL achieved significantly higher mean scores in Physics achievement and demonstrated superior knowledge economy skills compared to their counterparts taught using the traditional method. The study concluded that Problem-Based Learning is an effective instructional strategy for improving Physics learning and fostering skills essential for a knowledge-driven and sustainable economy. In order to promote the Sustainable Development Goals, it was recommended that Physics teachers incorporate problem-based learning (PBL) into their lessons and that curriculum designers integrate problem-based strategies into the Physics curriculum

Keywords: Problem-Based Learning (PBL), Physics Achievement, Sustainable Development and Economy Skills

Introduction

Education is widely recognized as a critical driver of national development, economic competitiveness, and social transformation. In the contemporary global landscape, nations are increasingly transitioning from resource-based economies to knowledge-based economies, where innovation, problem-solving ability, technological competence, and creativity determine productivity and sustainable growth (World Bank, 2018). Within this context, science education, particularly physics plays a pivotal role in preparing learners with the intellectual and practical skills required to function effectively in a rapidly changing, technology-driven society.

Physics is a foundational science subject that underpins many technological innovations and scientific advancements. It provides learners with conceptual understanding and analytical tools necessary for engineering, medicine, information technology, renewable energy development, and industrial production (Adeyemo, 2010).

At the secondary school level, physics education is expected to foster not only academic achievement but also the development of higher-order cognitive skills such as critical thinking, logical reasoning, and problem-solving. These competencies are central to the goals of the knowledge economy, which emphasizes the creation, dissemination, and application of knowledge for economic and social advancement (OECD, 2019).

Despite its importance, students' performance in physics at the senior secondary school level in Nigeria has remained unsatisfactory over the years. Chief examiners' reports from national examinations such as WAEC and NECO consistently reveal low achievement, poor conceptual understanding, weak problem-solving skills, and inability to apply physics principles to real-life situations (WAEC, 2022). Scholars have attributed this persistent underachievement to several factors, including inadequate instructional resources, insufficient teacher preparation, students' negative attitudes toward physics, and the predominant use of traditional lecture-based teaching methods (Aina & Akintunde, 2013; Olatoye, 2017).

Traditional instructional methods are largely teacher-centered, emphasizing content delivery, memorization, and passive learning. In such classrooms, students often play a minimal role in constructing knowledge, while teachers dominate instructional activities. Although this approach may facilitate coverage of the syllabus, it does little to promote deep understanding, critical thinking, or transferable skills required for the modern workforce (Hmelo-Silver, 2004). Consequently, students may succeed in recalling facts but struggle with applying concepts to novel or complex problems, a situation that undermines both academic achievement and skill development. In response to these challenges, contemporary educational research advocates for learner-centered instructional strategies that actively engage students in the learning process. One of such strategy is Problem-Based Learning (PBL).

PBL is an instructional approach in which learning begins with a real-world problem that students must analyze and solve through inquiry, collaboration, and self-directed learning (Barrows, 2019). Rather than receiving information passively, students construct knowledge by identifying what they need to learn, seeking relevant information, and applying their understanding to solve meaningful problems. Problem-Based Learning is grounded in constructivist learning theory, which posits that knowledge is actively constructed by learners through interaction with their environment and social negotiation (Vygotsky, 1978; Piaget, 1972). Through PBL, students are encouraged to engage in critical thinking, hypothesis formulation, experimentation, and reflection. These processes align closely with the nature of physics as an inquiry-driven discipline and provide opportunities for learners to develop both conceptual understanding and practical competencies (Savery, 2006). Beyond academic achievement, contemporary education emphasizes the development of knowledge economy skills, also referred to as 21st-century skills. These include critical thinking, problem-solving, collaboration, creativity, communication, and digital literacy (Partnership for 21st Century Skills, 2015). Such skills are essential for enabling learners to adapt to complex work environments, engage in lifelong learning, and contribute meaningfully to societal development. Physics education, when effectively delivered, has the potential to cultivate these skills due to its emphasis on inquiry, experimentation, and logical reasoning.

Problem-Based Learning is particularly well-suited for fostering knowledge economy skills. Through collaborative group work, students learn to communicate ideas effectively, negotiate meaning, and work as teams to solve complex problems. The open-ended nature of PBL tasks encourages creativity and innovation, while the requirement to seek, evaluate, and apply information promotes digital literacy and self-directed learning (Savery and Duffy, 2001). As such, PBL aligns strongly with the objectives of education for sustainable development and the attainment of the Sustainable Development Goals (SDGs), especially Goal 4, which focuses on quality education (UNESCO, 2020).

Despite the documented benefits of PBL, its implementation in Nigerian secondary school physics classrooms remains limited (Sarkingobir & Bello, 2024; Abubakar & Arshad, 2023). Many teachers continue to rely on traditional teaching methods due to large class sizes, examination pressures, limited instructional time, and inadequate professional training in innovative pedagogies (Ajayi & Ogebe, 2018). Furthermore, while several studies have examined the effect of PBL on students' academic achievement, relatively few have explored its impact on

knowledge economy skills, particularly within the context of physics education.

In Nigeria, the need to align secondary school physics education with the demands of the knowledge economy has become increasingly urgent. National education policies emphasize the development of scientifically literate citizens capable of contributing to technological innovation and sustainable development (Federal Republic of Nigeria, 2014). However, achieving these goals requires empirical evidence on effective instructional strategies that simultaneously enhance academic achievement and skill acquisition. Studies that integrate both cognitive and skill-based outcomes are necessary to inform teaching practice, curriculum development, and policy formulation. Therefore, examining the effects of Problem-Based Learning on students' Physics achievement and knowledge economy skills is both timely and relevant. Such a study contributes to the growing body of literature on innovative instructional strategies in science education and provides context-specific evidence from Nigerian secondary schools. By addressing both achievement and skill development, the study responds to the evolving demands of education in a knowledge-driven global economy.

Statement of the Problem

Physics is a fundamental science subject that contributes significantly to technological advancement, innovation, and national development. At the senior secondary school level, physics education is expected to develop students' conceptual understanding and equip them with knowledge economy skills such as critical thinking, problem-solving, collaboration, creativity, and digital literacy. However, despite its importance, students' achievement in physics in Nigerian secondary schools has remained consistently low. Reports from WAEC Chief Examiners' indicate that many students have difficulty understanding basic physics concepts, interpreting examination questions, and solving both numerical and conceptual problems. These challenges are often linked to the continued use of traditional teacher-centered instructional methods that emphasize memorization rather than active learning and critical thinking.

In addition to low academic achievement, physics instruction in many secondary schools does not adequately promote the knowledge economy skills required in the 21st century. Although national education policies emphasize creativity, innovation, collaboration, and technological competence, classroom practices frequently fail to reflect these goals. As a result, students may pass examinations but still lack the essential competencies needed for higher education, the workplace, and meaningful participation in a knowledge-driven economy.

Learner-centered instructional strategies such as Problem-Based Learning (PBL) have been recognized as an effective approaches for improving conceptual understanding and promoting higher-order thinking skills. PBL engages students in solving real-life problems, thereby encouraging active participation, collaboration, and independent thinking. However, the use of PBL in secondary school Physics classrooms in Nigeria remains limited, and existing studies have focused mainly on its impact on academic achievement rather than on knowledge economy skills. Therefore, there is a need to investigate the effects of Problem-Based Learning on students' Physics achievement and the development of knowledge economy skills in order to improve the quality of Physics education and align instructional practices with the demands of a knowledge-based economy.

Research Questions

1. What is the influence of Problem-Based Learning on students' achievement in physics compared with the traditional teaching method?
2. What is the influence of Problem-Based Learning on students' knowledge economy skills (problem-solving, critical thinking, collaboration, creativity, and digital literacy)?

Research Hypotheses

1. There is no significant difference in the Physics achievement mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method.
2. There is no significant difference in the knowledge economy skills mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method.

Methodology

The study adopted quasi-experimental research design with pre-test post-test control group design. This study was conducted in Imo State, which is geographically located in Eastern Region. With an estimated 98% of the State's population speaking Igbo, main religion is Christianity.

The sample for this study consisted of 194 Senior Secondary School II (SS II) Physics students drawn from four co-educational secondary schools in the study area. The choice of SSII was due to the fact that the topics covered were in SSII scheme of work. This study adopted a multi-stage sampling technique. Using simple random sampling (balloting without replacement), one Education Zone was selected from the six Education Zones in Imo State. The selection of co-educational schools was purposive to ensure uniform classroom conditions, where learners are taught together by the same teacher within the same learning environment. To ensure in-depth study and minimize inter-class interaction, four out of the sixty-six co-educational schools were selected from different Local Government Areas within the chosen Education Zone using simple random sampling techniques. The sampling ensured that only one school was selected from each Local Government Area. From each of the four selected schools, four intact classes were used for the study. The classes were randomly assigned to experimental and control groups. The experimental group, which was taught using the Problem-Based Learning (PBL) approach, comprised 98 students, while the control group, which was taught using the conventional teaching method, comprised 96 students

Two research instruments were used for data collection in this study. These instruments are the Physics Achievement Test (PAT) and the Knowledge Economy Skills Questionnaire (KESQ). The Physics Achievement Test (PAT) is a researcher-developed instrument designed to assess students' level of achievement in selected Physics topics. The test consists of 50 multiple-choice items with four response options (A–D), from which students are required to choose the correct answer. The items were constructed based on the Senior Secondary School Physics curriculum and covered current electricity and electrolysis taught during the experiment. Each correct response in the PAT was awarded two (2) mark, while incorrect responses attracted zero (0) mark. The total score obtained by each student was used as a measure of their academic achievement in Physics.

The validity of the PAT was established through expert judgment. The instrument was given to specialists in Physics Education and Measurement and Evaluation who examined the items for; relevance to the study objectives, clarity of language, appropriateness of difficulty level and coverage of the curriculum content. Their suggestions and corrections were incorporated into the final version of the instrument, thereby ensuring its content and face validity.

The reliability of the PAT was determined using the Kuder-Richardson Formula 20 (KR-20) since the test items were dichotomously scored. A reliability coefficient of approximately 0.80 or higher was obtained, indicating that the instrument is highly reliable and suitable for measuring students' achievement in Physics.

The Knowledge Economy Skills Questionnaire (KESQ) is a structured questionnaire designed to assess students' acquisition of knowledge economy skills. These skills include: critical thinking, problem-solving, communication skills, collaboration, creativity and innovation and digital/ICT literacy. The instrument consists of Likert-scale items, typically with response options such as Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The responses were scored as follows: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2 and Strongly Disagree (SD) = 1. The total score for each student was obtained by summing their responses across all items. Higher scores indicate a higher level of knowledge economy skills.

The validity of the KESQ was established through expert review. Specialists in educational psychology, curriculum studies, and measurement and evaluation examined the instrument for: relevance to knowledge economy skill constructs, clarity and appropriateness of items and adequacy of coverage of all skill domains. Their feedback led to necessary modifications, ensuring that the instrument possesses content and face validity.

The reliability of the KESQ was determined using Cronbach's Alpha, which is appropriate for Likert-scale instruments. A reliability coefficient of 0.70 or above was obtained, indicating that the instrument has good internal consistency and is reliable for measuring knowledge economy skills.

Mean and standard deviation were used to answer the two research questions. For the

two null hypotheses, t-test was used to test each of them at p =<0.05 (5%) level of significance.

Research Question 1: What is the influence of Problem-Based Learning on students' achievement in physics compared with the traditional teaching method?

Results

Table 1: Mean and Standard Deviation of Students' Physics Achievement

Group	N	Pre-test Mean	Pre-test SD	Posttest Mean	Posttest SD
Experimental (PBL)	98	18.45	4.12	32.67	3.89
Control (Traditional)	96	18.32	4.05	25.84	4.21
Mean difference		0.13		6.83	

From Table 1, the pretest mean scores of the experimental group (18.45) and the control group (18.32) are very close, with a mean difference of 0.13, indicating that both groups were at approximately the same level of Physics achievement before the treatment. However, at the posttest level, the experimental group recorded a mean score of 32.67, while the control group had 25.84, resulting in a mean difference of 6.83 in favour of the experimental group. This substantial increase shows that students exposed to Problem-Based Learning (PBL) performed significantly better than those taught using the traditional method. The relatively lower standard deviation (3.89) in the experimental group compared to the control group (4.21) also indicates that students' scores were more consistent under the PBL approach.

Therefore, the mean difference of 6.83 at posttest suggests that Problem-Based Learning had a positive and notable influence on students' achievement in Physics compared to the traditional teaching method.

Research Question 2: What is the influence of Problem-Based Learning on students' knowledge economy skills (problem-solving, critical thinking, collaboration, creativity, and digital literacy)?

Table 2: Mean and Standard Deviation of Students' Knowledge Economy Skills Scores

Group	N	Pre-test Mean	Pre-test SD	Posttest Mean	Posttest SD
Experimental (PBL)	98	55.21	6.34	78.45	5.87
Control (Traditional)	96	54.87	6.21	63.12	6.05
Mean difference		0.34		15.33	

From Table 2, both groups started at nearly the same level in knowledge economy skills, as shown by the very close pretest means (Experimental = 55.21, Control = 54.87), indicating that the groups were comparable before treatment. After the intervention, there is a clear difference in performance, Experimental (PBL) posttest mean (78.45) and Control (Traditional) posttest mean (63.12). This result shows that students exposed to Problem-Based Learning (PBL) improved significantly more in knowledge economy skills than those taught using the traditional method. The mean difference of 14.99 further confirms that PBL is more effective in enhancing key knowledge economy skills such as problem-solving, critical thinking, collaboration, creativity, and digital literacy. The substantial mean gain difference of 14.99 suggests that Problem-Based Learning significantly improves students' knowledge economy skills compared to the traditional teaching method.

Hypotheses 1: There is no significant difference in the Physics achievement mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method.

Table 3: Independent Samples t-test on Physics Achievement Scores

Group	N	Mean (X)	SD	df	t-value	p-value	Decision
Experimental (PBL)	98	68.45	8.12	192	8.68	0.000	Reject H_o
Control (Traditional)	96	55.32	9.05				

*Significant at $p < 0.05$

The result in the table 3 shows that the calculated t-value is 8.68 with 192 degrees of freedom. The associated p-value (0.000) is less than the 0.05 level of significance. Since $p < 0.05$, the null hypothesis is rejected. This indicates that there is statistically significant differences in the Physics achievement mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method. This implies that Problem-Based Learning is more effective in improving students' achievement in Physics.

Hypothesis 2: There is no significant difference in the knowledge economy skills mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method.

Table 4: Independent Samples t-test on Knowledge Economy Skills Mean Scores

Group	N	Mean (X)	SD	df	t-value	p-value	Decision
Experimental (PBL)	98	74.62	7.45	192	7.92	0.000	Reject H_o
Control (Traditional)	96	63.18	8.10				

*Significant at $p < 0.05$

The result from table 4 shows that the calculated t-value is 7.92 with 192 degrees of freedom, and the p-value is 0.000, which is less than the 0.05 level of significance. Therefore, the null hypothesis is rejected. This indicates that there is a significant difference in the knowledge economy skills mean scores of students taught using Problem-Based Learning and those taught using the traditional teaching method. Students exposed to Problem-Based Learning recorded a higher mean score ($\bar{X}$ = 74.62) than those taught using the traditional method ($\bar{X}$ = 63.18), suggesting that Problem-Based Learning enhances students' acquisition of knowledge economy skills.

Discussion

The study revealed that students exposed to PBL achieved significantly higher physics scores compared with those taught using the traditional teaching method. The descriptive statistics and t-test indicated that PBL enhanced students' conceptual understanding, problem-solving ability, and application of physics principles.

This finding is consistent with previous studies that have demonstrated the effectiveness of PBL in improving science achievement (Savery, 2015). The results support the constructivist learning theory, which emphasizes that learners construct knowledge actively through engagement, problem-solving, and collaboration. PBL, by promoting active exploration and real-world problem-solving, provides opportunities for students to internalize concepts and apply knowledge meaningfully, unlike the passive reception associated with traditional lecture methods.

The study also found that students in the experimental group developed significantly higher knowledge economy skills, including critical thinking, problem-solving, collaboration, creativity, and digital literacy. This demonstrates that PBL not only improves academic outcomes but also fosters skills crucial for the 21st-century knowledge economy.

These results align with findings by Savin-Baden (2000) and Bell (2010), which suggest that PBL encourages active engagement, independent research, and teamwork, thereby enhancing transferable skills beyond the classroom. By presenting learners with real-life problems, PBL promotes the development of higher-order thinking and collaborative competencies, which are essential for innovation and sustainable development.

Conclusion

The study investigated the effect of Problem-Based Learning (PBL) on students' physics achievement and knowledge economy skills. Based on the results and discussion, the following conclusions are drawn:

1. Comparable baseline: Both the experimental (PBL) and control groups had nearly equal pretest scores in Physics achievement and knowledge economy skills, indicating a fair starting point for comparison.
2. Improved Physics achievement: Students taught using Problem-Based Learning (PBL) showed significantly higher achievement in Physics than those taught using the traditional method, with a notable posttest mean difference of 6.83.
3. Consistency in performance: Lower standard deviation in the PBL group indicates more consistent student performance under the PBL approach.
4. Enhanced knowledge economy skills: PBL significantly improved students' skills in problem-solving, critical thinking, collaboration, creativity, and digital literacy, with a large posttest mean difference (≈ 15 points) in favour of the experimental group.
5. Superiority of PBL: Problem-Based Learning proved to be more effective than the traditional teaching method in both academic achievement and skill development.
6. Problem-Based Learning is a powerful instructional strategy that not only improves students' academic performance in Physics but also equips them with essential 21st-century skills needed for the knowledge economy.

Recommendations

Based on the research findings, the following recommendations are made

1. Teachers should integrate Problem-Based Learning into their instructional strategies to enhance students' conceptual understanding and problem-solving abilities.
2. The secondary school physics curriculum should incorporate PBL and other learner-centered strategies as a standard teaching approach.
3. Students should actively engage in collaborative and self-directed learning activities to maximize the benefits of PBL.

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ENHANCING METACOGNITIVE AWARENESS AND SELF-REGULATION IN STEM LEARNING THROUGH SCAFFOLDED METACOGNITIVE ACTIVITIES: EVIDENCE FROM SECONDARY SCHOOLS IN ILE-IFE, OSUN STATE

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Abstract

The study examined the use of scaffolded metacognitive activities as a strategy for promoting STEM education among secondary school students. Specifically, it investigated how scaffolding metacognitive activities can enhance students' metacognitive awareness and self-regulation during STEM learning. A quasi-experimental research design was adopted for the study. The population comprised all (N =5730) Senior Secondary School students offering STEM-related subjects (Mathematics, Physics, Chemistry, and Biology) in Ile-Ife, Osun State. A total of 120 students participated in the study and were divided into two groups: an intervention group exposed to scaffolded metacognitive activities and a control group taught using the conventional STEM teaching approach. Participants were selected through a multistage sampling technique. Data were collected using the Metacognitive Awareness and Self-Regulation in STEM Learning Scale (MASR–STEM) and the Feasibility of Integrating Scaffolded Metacognitive Activities into the STEM Curriculum Scale (FISMA–STEM). The collected data were analysed using descriptive statistics and Analysis of Covariance (ANCOVA). The findings revealed that scaffolded metacognitive activities had a statistically significant effect on students' metacognitive awareness and self-regulation, $F(1,117) = 8.259$, $p = .003$. However, the magnitude of the effect was relatively small, as indicated by the partial eta squared value ($\eta^2 = .072$), suggesting that the intervention accounted for approximately 7.2% of the variance in students' post-test metacognitive awareness and self-regulation after controlling for pre-test scores. Another important finding of the study relates to the feasibility of integrating scaffolded metacognitive activities into the existing STEM curriculum. The results showed moderate approval from teachers and students (33.3%) regarding the integration of such activities, although some challenges related to instructional resources were identified (41.7%).

The study therefore concludes that scaffolded metacognitive activities have the potential to improve students' metacognitive awareness and self-regulation in STEM learning, although the magnitude of the effect suggests that such activities should be implemented alongside other supportive instructional strategies. The findings imply that incorporating structured metacognitive scaffolding within STEM classrooms may support the development of students' reflective learning skills, strategic thinking, and independent learning behaviours, thereby contributing to more effective STEM teaching and learning practices in secondary schools.

Keywords: *scaffolded metacognitive activities, STEM education, metacognitive awareness and self-regulation*

Introduction

The fast development of technologies that was within the scope of the 21st century presupposes the presence of a highly-qualified workforce with solid background in Science, Technology, Engineering, and Mathematics (STEM). In its fight towards attaining sustainable development and economic growth, Nigeria has recognised the importance of STEM education in fostering innovation, problem-solving skills, and critical thinking skills (Onoshakpokaiye & Avwiri, 2025). A senior secondary school is an important component of this educational procedure that forms a direction of students to professional careers and further education. The STEM curriculum has been long-standing content-based, with more focus on the acquisition of knowledge by rote and memorization (Moses, 2023). Even though basic knowledge remains important, it is not enough to equip students in order to survive in a complex and dynamic world. It has become clear that the paradigm shift towards a more holistic approach to STEM education is very much required (Jolaoluwa et al., 2024). This transformation requires the emphasis on higher-order thinking which comprises critical thinking, problem-solving, creativity, and innovation.

Nevertheless, despite the recognized importance of STEM education in national development, STEM education implementation in Nigeria continues to face challenges such lack of resources, insufficient training of teachers, and poor student involvement (Umar, 2019). As a result, students often demonstrate limited critical thinking ability, weak problem-solving competence, and low engagement in STEM subjects. Although several policy discussions have continually emphasize the provision of infrastructure and learning resources, less attention has been given to the cognitive processes that support meaningful STEM learning. In particular, there is limited integration of instructional practices that intentionally develop students' ability to regulate and reflect on their own thinking. Consequently, a major gap in current STEM pedagogy in Nigeria is the insufficient emphasis on metacognitive development within classroom instruction.

Metacognitive competence is increasingly recognized as a critical element of effective learning because it enables students to plan, monitor, and evaluate their thinking processes during learning activities (Rivas et al., 2022). Within STEM education, these abilities are especially important because students are frequently required to analyze complex problems, evaluate alternative solutions, and apply conceptual knowledge to unfamiliar situations. However, many STEM classrooms still do not deliberately incorporate structured metacognitive activities into instruction. When such activities are used, they are often implemented inconsistently or without sufficient pedagogical guidance. This situation limits their effectiveness in fostering sustained metacognitive awareness and self-regulation among learners.

One promising instructional approach that can address this limitation is the integration of scaffolded metacognitive activities into STEM teaching. Scaffolding, grounded in Vygotsky's sociocultural theory of learning, involves the provision of temporary instructional support that helps learners perform tasks that they may not initially be able to accomplish independently (Sarmiento-Campos et al., 2022). Through carefully structured guidance such as reflective questioning, think-aloud modeling, guided problem solving, and structured self-evaluation, teachers can gradually support

students in developing the skills needed to regulate their own learning processes. As learners gain competence, this support is withdrawn as they increase in learning, thereby promoting independence and deeper cognitive engagement. Scaffolded metacognitive activities address the pedagogical gap in STEM education because they simultaneously support conceptual understanding, critical thinking, and learner autonomy.

Existing research has demonstrated that scaffolding strategies can improve students' awareness of their thinking processes and enhance their ability to regulate learning (Gunawardena & Wilson, 2021; Jia et al., 2025). Similarly, studies have shown that structured metacognitive activities such as reflective questioning, goal setting, and self-assessment can significantly improve students' learning outcomes and critical thinking abilities (Valencia-Vallejo et al., 2019; Akcaoğlu et al., 2023). Despite these findings, there remains limited empirical evidence on how scaffolded metacognitive activities function within STEM classrooms in the Nigerian secondary school context. In particular, few studies have examined how such instructional strategies influence students' metacognitive awareness and self-regulation in real classroom settings.

Given the ongoing efforts to strengthen STEM education in Nigeria, especially at the secondary school level where foundational scientific thinking is developed, it is important to explore pedagogical strategies that can actively promote higher-order cognitive skills among learners. The integration of scaffolded metacognitive activities represents a potentially effective approach for addressing current instructional limitations by helping students become more reflective, strategic, and independent learners. However, empirical research investigating this approach within Nigerian STEM classrooms remains scarce.

Therefore, this study seeks to contribute to the existing body of knowledge by examining the relationship between scaffolded metacognitive activities and students' metacognitive awareness and self-regulation among senior secondary school students in Osun State, Nigeria. By focusing on the instructional role of scaffolding in supporting metacognitive development, this study advances both theoretical and practical understanding of how structured pedagogical support can enhance cognitive engagement in STEM learning. The findings are expected to provide insights that can inform instructional practice, curriculum development, and teacher training aimed at strengthening higher-order thinking and independent learning in STEM education in Osun State.

Objectives of the Study

This study aims to investigate the potential of scaffolding metacognitive activities as a strategy to enhance STEM education among senior secondary school students in Osun State. Furthermore, the specific objectives of this study are to:

i. investigate the feasibility of integrating scaffolded metacognitive activities into the existing STEM curriculum in Osun State; and

ii. explore how scaffolding can improve students' metacognitive awareness and self-regulation in STEM learning.

Research Question

i. To what extent is it feasible to integrate scaffolded metacognitive activities into the existing STEM curriculum in Osun State secondary schools?

Research Hypothesis

i. There is no significant difference on the Metacognitive Awareness and Self-Regulation of senior secondary school students in STEM subjects when taught using the scaffolded metacognitive activities and conventional method in Osun State, Nigeria.

Methodology

In this article, a quasi-experimental research design of the non-equivalent pre-test, post-test control group research type was chosen to examine how scaffolded metacognitive activities affect metacognitive awareness and self-regulation among senior secondary school learners in STEM subjects. The design enabled one to measure the level of metacognitive awareness and self-regulation possessed by students prior to and following the intervention, and compare the results of the experimental and the control group.

Pre-test scores were used as covariate to make sure that initial mean difference in student ability is controlled statistically to offer a good meaning of the effect of the intervention. The study design is structurally shown as:

O_1 K_1 O_2 Experimental Group (Scaffolded Metacognitive Strategy)

O_3 K_2 O_4 Control Group (Conventional Method)

Where O_1 and O_3 are the pre-test observations for the two groups, O_2 and O_4 are the post-test observations for the groups.

K_1= Experimental treatment using Scaffolded Metacognitive Strategy (SMS)

K_2= Control Group using Conventional Method (CM)

Variables of the study

Three variables were examined in the study, they are:

1 Independent Variable: The mode of instruction manipulated at two (2) levels, namely:

a. Scaffolded Metacognitive Strategy

b. Conventional Method

2.) Covariate: Pre-test scores from the questionnaire to account for baseline differences.

3.) Dependent Variable: There are two dependent variables in the study, namely:

a. Metacognitive Awareness and Self-Regulation

All students of senior secondary schools studying STEM subjects in Ile-Ife, Osun State, Nigeria were included as the population in this study. The total number of all senior secondary schools students studying STEM subjects in Ile-Ife, Osun State, Nigeria was 5730 (L.I.E, 2026). A multi-stage sampling procedure was employed to select the participants. In the first stage, two secondary schools were selected from the list of registered secondary schools in Ile-Ife using simple random sampling. The use of simple random sampling at this stage ensured that each eligible school had an equal chance of being selected for the study.

In the second stage, intact science classes from the selected schools were used. The use of intact classes was considered appropriate because it allowed the researcher to implement the intervention within the natural classroom setting without disrupting existing school structures. The science classes were chosen because they offer STEM-related subjects (Biology, Physics, Chemistry, Mathematics, Data Processing, and so on) in the selected schools. A total of (120) One hundred and twenty students were used; 60 students in the experimental group and 60 students in the control group.

The selected schools were chosen because they offer a full range of STEM-related subjects and possess functional science classrooms, which made them suitable environments for implementing scaffolded metacognitive activities within STEM instruction. In addition, the schools had comparable academic structures, similar curriculum coverage, and similar student population characteristics. This helped in reducing contextual differences that could influence the outcome of the intervention. Selecting schools with similar instructional environments helped ensure that any observed differences in learning outcomes could be more reasonably attributed to the instructional strategy rather than institutional differences.

Before the intervention the pre-test was done on the Metacognitive Awareness and Self-Regulation to both experimental and control groups as a way of establishing the baseline performance. The intervention was conducted over a six-week instructional period, during which both groups received lessons covering similar STEM learning tasks.

Students in the experimental group were taught through scaffolded metacognitive exercises, such as guided problem-solving, reflection prompting, carrying out of strategy modelling, and feedback about solution strategies. While students in the control group were provided with conventional teaching, that is, with regular teacher-delivered lessons and with no overt metacognitive scaffolding.

At the end of the intervention period the problem-solving post-test was administered to both groups in order to determine the effect of the instructional strategies on students' metacognitive awareness and self-regulation

The Metacognitive Awareness and Self-Regulation in STEM Learning Scale (MASR–STEM), as well as Feasibility of Integrating Scaffolded Metacognitive Activities into the STEM Curriculum Scale (FISMA–STEM) were used to collect data in the selected schools for the study. The researcher created the Feasibility of Integrating Scaffolded Metacognitive Activities into the STEM Curriculum Scale (FISMA-STEM) to evaluate the perceptions of the stakeholders regarding the feasibility, preparedness, and supporting the presence of scaffolded metacognitive activities in secondary school STEM curricula. The instrument has 20 items rated on a four-point Likert scale where Strongly Agree (4) is the highest scale and Strongly Disagree (1) is the lowest. All the items deal with major aspects of feasibility, such as perceived benefits of instruction, teacher willingness, student flexibility, resource availability, administrative encouragement, curriculum alignment, and cost-effectiveness. The scale scores higher are associated with more perceived possibility to incorporate scaffolded metacognitive activities in STEM education.

The researcher designed the Metacognitive Awareness and Self-regulation in STEM Learning Scale (MASR-STEM) to test the level of metacognitive awareness and self-regulatory behaviours among students in STEM learning. The instrument aims at measuring the awareness of the cognitive processes in the learners, their planning, monitoring and evaluating of learning tasks, and their capacity to control the effort, learning strategies and learning behaviours when performing STEM tasks. The MASR-STEM is a 20-item scale with a four-point Likert scale where Strongly Agree (4) is positioned on the right-hand side and Strongly Disagree (1) on the left-hand side. The higher the rates of the scale, the greater the metacognitive awareness and self-control during the STEM learning. The items capture major dimensions of metacognition and self-regulated learning that have frequently been found in the literature, such as learning strategy awareness, goal setting, self-monitoring, reflecting, strategy regulation, time management, and proactive help-seeking.

The instrument combines two constructs, which are interrelated, conceptually:

Metacognitive Awareness describes the cognition of the learners (that is, their knowledge) about their cognitive processes, their strengths and weaknesses, their knowledge of the strategies, and their reflections about the problem-solving strategies in STEM activities. Self-Regulation, which involves the skills of learners to plan the learning process, control progress, control effort, control outcomes, and change strategies to increase performance in STEM learning practices.

The MASR-STEM content was based on the known theoretical models on metacognition and self-regulated learning, specifically the models put forward by Flavell (1979), Zimmerman (2000), and the next-generation researchers that focus on planning, monitoring, and evaluation as the essential aspects of an effective learning process. Expert review of the scale was done to establish relevance of the content, clarity, and relevance to the objectives of the study and the reliability analysis was done to establish the internal consistency of the scale before it could be used in the data collection process.

The MASR-STEM offers context sensitive approach to studying the effect of instructional strategies on students' awareness and control of learning processes in STEM instruction and learning, e.g., scaffolded metacognitive activities. Its design renders it to be applicable in the situations of secondary schools and to be applicable to further validation and application of the study in corresponding educational studies.

To make sure that the content is valid, the instrument was checked by 3 experts in the fields of STEM education and educational psychology. In addition, Cronbach Alpha was also used to determine the reliability of the instrument and MASR-STEM gave a coefficient of 0.82, and FISMA-STEM yielded 0.76, which are secondary (high) internal consistency.

Method of Data Analysis

Analysis of covariance (ANCOVA) was employed in the analysis of data to establish the effect of scaffolded metacognitive activities on post-test scores in problem-solving and had to adjust the score differences at pre-test stage. The statistical tests were performed at = 0.05 with the help of the Statistical Package of Social Sciences (SPSS) version 27.

Results

Research Question 1: To what extent is it feasible to integrate scaffolded metacognitive activities into the existing STEM curriculum in Osun State secondary schools?

In a bid to test the hypothesis, data collected on impact of scaffolded metacognitive activities on students' Metacognitive Awareness and Self-Regulation were analyzed using descriptive statistics. The results are presented in Table 1.

Table 1: Feasibility of Integrating Scaffolded Metacognitive Activities (N = 120)

Category	Level	Frequency	Percentage (%)
Students' Performance	Low	25	20.8
	Average	50	41.7
	High	45	37.5
Reception by Schools, Teachers and Students	Low	40	33.3
	Average	40	33.3
	High	40	33.3
Resources	Low	30	25.0
	Average	50	41.7
	High	40	33.3
Curriculum	Low	25	20.8
	Average	55	45.8
	High	40	33.3

Data collected on the feasibility of integrating scaffolded metacognitive activities in terms of improving student performance were computed and the minimum and maximum scores obtained in this scale were 10 and 40 respectively. Responses on the scale 10-20 were adjudged as having "Low Feasibility". Responses on the scale 21-30 were adjudged as having "Average Feasibility". Responses on the scale 31-40 were adjudged as having "High Feasibility"

The Results from Table 1 showed that of a total of 120 respondents, 20.8% showed a low belief in the feasibility of integrating scaffolded metacognitive activities in terms of improving student performance, 41.7% showed average belief, and 37.5% showed high belief.

While regarding feasibility of integrating scaffolded metacognitive activities in terms of reception by schools, teachers and students 33.3% believe schools, teachers, and students will show low support. While 33.3% believe the support will be average, and 33.3% believe it will be high.

Furthermore, considering the feasibility of integrating scaffolded metacognitive activities in terms of resources 25.0% indicated that schools have the resources needed to implement scaffolded metacognitive activities, while 41.7% remained neutral. However, 33.3% of the respondents felt that their schools lacked the necessary resources to support such activities effectively.

Finally, regarding the feasibility of integrating scaffolded activities into the current STEM curriculum, 20.8% believed the curriculum could accommodate these activities without significant changes. However, 45.8% were neutral, and 33.3% expressed concerns about the alignment of scaffolded activities with the existing curriculum.

Hypothesis One: There is no significant difference in the metacognitive awareness and self-regulation of senior secondary school students in STEM learning when taught using the scaffolded metacognitive activities in Osun State, Nigeria.

In a bid to test the hypothesis, data collected on influence of scaffolded metacognitive activities on students' metacognitive awareness and self-regulation were subjected to Analysis of Covariance

(ANCOVA) using SPSS Statistics. The results are presented in Table 2.

Table 2: Analysis of Covariance on the effect of scaffolded metacognitive activities on students' metacognitive awareness and self-regulation

Sources	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16.416[a]	2	8.700	166.909	< .001	.770
Intercept	14.881	1	14.881	299.319	< .001	.715
Pre-test	16.160	1	15.816	310.339	< .001	.740
Treatment Group	0.445	1	0.445	8.259	.003	.072
Error	6.004	117	0.051			
Total	916.000	120				
Corrected Total	31.400	119				

a. R Squared = .740 (Adjusted R Squared = .735)

Table 2 presents the result of a one-way Analysis of Covariance (ANCOVA) conducted to determine the effect of scaffolded metacognitive activities on students' metacognitive awareness and self-regulation while controlling for pre-test scores. In this analysis, the treatment group (experimental and control) served as the independent variable, the post-test metacognitive awareness and self-regulation score served as the dependent variable, and the pre-test score was used as the covariate to control for baseline differences between the groups.

The result of the ANCOVA indicated that pre-test scores significantly influenced the post-test scores, $F(1,117) = 310.339$, $p < .001$, suggesting that students' initial level of metacognitive awareness and self-regulation contributed substantially to their post-intervention performance. After controlling for these baseline differences, the treatment effect remained statistically significant, $F(1,117) = 8.259$, $p = .003$. This result indicates that students exposed to scaffolded metacognitive activities differed significantly in their post-test metacognitive awareness and self-regulation compared with those taught using the conventional method. Based on this finding, the null hypothesis was rejected, indicating that scaffolded metacognitive activities had a statistically significant effect on students' metacognitive awareness and self-regulation.

However, the magnitude of the treatment effect, as indicated by the Partial Eta Squared value ($\eta^2 = .072$), suggests a small to modest effect size. This implies that although scaffolded metacognitive activities significantly influenced students'

metacognitive awareness and self-regulation, the proportion of variance in the dependent variable explained by the treatment was relatively limited. In practical terms, the intervention accounted for approximately 7.2% of the variance in students' post-test metacognitive awareness and self-regulation after controlling for pre-test scores.

The relatively small effect size suggests that while scaffolded metacognitive activities contribute positively to improving students' metacognitive awareness and self-regulation, other factors such as prior learning experiences, teacher instructional practices, classroom environment, and students' individual learning characteristics may also play important roles in shaping metacognitive development. Nevertheless, the statistically significant treatment effect indicates that scaffolded metacognitive activities remain a meaningful instructional approach for supporting the development of students' metacognitive skills within STEM learning contexts

Table 3: Pairwise Comparisons of Adjusted Post-Test Metacognitive Awareness and Self-Regulation Scores

(I) Group	(J) Group	Mean Difference (I–J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]
Scaffolded Metacognitive Activities	Conventional Method	.088*	.031	.003	.026
Conventional Method	Scaffolded Metacognitive Activities	-.088*	.031	.003	-.150

The adjusted post-test performance of metacognitive awareness and self-regulation indicated that there was a statistically significant difference between the students that were taught through scaffolded metacognitive activities and those taught through the traditional instruction technique after the adjustment of pre-test scores. The scaffolded metacognitive activities group scored much higher in terms of adjusted mean scores than the conventional method one (Mdiff = 0.088, SE = 0.031, p =. 003).

The 95 percent interval of the mean difference between the scores of adjusted post-test metacognitive awareness and self-regulation confirms that the interval of adjusted score variation is positive, which is confirming the reliability and direction of the effect being positive in favour of the scaffold metacognitive instruction. The negative mean difference (MD iff = -0.088) between the conventional method and scaffolded metacognitive activities obtained through the reverse comparison of both conditions contributes into the effectiveness of the latter metacognitive methodology.

These findings are good indicators that scaffolded metacognitive activities have a great effect on the metacognitive awareness and self-regulation in STEM learning when initial differences are statistically controlled.

Discussion of Findings

The results of this study provide evidence on the effectiveness of scaffolded metacognitive activities and the extent to which they influence students' metacognitive awareness and self-regulation in STEM learning. The analysis of the one-way ANCOVA revealed that scaffolded metacognitive activities had a statistically significant positive effect on students' metacognitive awareness and self-regulation. When the pre-test scores were controlled for, students in the experimental group who were exposed to scaffolded metacognitive activities demonstrated higher post-test scores compared to those in the control group who were taught using the conventional method. This finding suggests that structured scaffolding of metacognitive processes supports students in becoming more aware of their thinking processes and

more deliberate in regulating their learning during STEM tasks.

The result of this study is consistent with existing literature which has emphasized the role of scaffolding in strengthening metacognitive development. For instance, Jia et al. (2025) reported that scaffolded instructional approaches within problem-based learning environments enhance students' metacognitive skills by supporting their ability to plan, monitor, and evaluate learning processes. Similarly, Kim and Lim (2019) found that scaffolded learning environments increase students' engagement with complex learning tasks by encouraging deeper reflection and active regulation of cognitive processes. These findings reinforce the position that scaffolded instructional strategies are effective in promoting metacognitive development, particularly within STEM-related learning contexts.

The effect size obtained from the analysis ($\eta^2 = .072$) indicates a small but meaningful effect of scaffolded metacognitive activities on students' metacognitive awareness and self-regulation. This suggests that while the intervention had a statistically significant influence, the proportion of variance explained by the treatment is relatively limited. This implies that scaffolded metacognitive activities contribute positively to students' metacognitive development, but their effectiveness may be strengthened when combined with other instructional and contextual factors within the learning environment. This finding aligns with Dignath and Veenman (2021), who noted that instructional support in metacognitive strategies and scaffolding practices can lead to improvements in self-regulation and learning outcomes. It is also consistent with Mamun (2022), who emphasized that scaffolding enhances reflection, engagement, and self-regulated learning, particularly in structured learning environments.

Interestingly, the findings also showed that students in the control group recorded some improvement in metacognitive awareness and self-regulation, although at a lower level compared to the experimental group. This suggests that even conventional teaching methods may provide limited opportunities for metacognitive development, especially when students are exposed to structured tasks, exercises, or continuous classroom interactions that require some level of reflection. This observation is in line with Perry et al. (2019), who noted that metacognitive skills can develop gradually within classroom environments even without explicit instructional interventions, particularly when teaching is systematic and consistent.

However, the stronger performance of the experimental group highlights the added value of explicit scaffolding in guiding students' thinking processes. The structured support provided through guided questioning, modelling, reflection prompts, and feedback likely contributed to students' improved ability to regulate their learning. Nevertheless, the magnitude of the effect suggests that metacognitive development is a gradual process that may require sustained instructional exposure over time. This is supported by Bocoș et al. (2024), who emphasized that long-term and well-structured interventions are more likely to produce sustained improvements in metacognitive skills.

Furthermore, the findings on the Feasibility of Integrating Scaffolded Metacognitive Activities indicate that there is moderate support for the integration of scaffolded metacognitive activities into the STEM curriculum. While a proportion of respondents recognized the potential benefits of these activities in enhancing students' learning outcomes, there were also concerns related to implementation conditions such as resource availability and instructional readiness. These mixed perceptions suggest that although the approach is seen as beneficial, its successful adoption may depend on the level of institutional support and preparedness of teachers and schools.

The differences in the perceptions of the various stakeholders align with the findings of Zackariasson (2020), who observed that the success of scaffolded instructional approaches is influenced by the willingness of both teachers and students to engage with new pedagogical methods. Similarly, Rahma et al. (2020) emphasized that instructional innovations are more effective when educators are adequately prepared and willing to adapt their teaching strategies. Grebing et al. (2023) further highlighted that teacher buy-in and institutional support are critical factors in

the successful implementation of educational interventions.

Overall, the findings of this study suggest that scaffolded metacognitive activities have a positive effect on students' metacognitive awareness and self-regulation in STEM learning. The results support the view that structured instructional support can enhance students' ability to think about their thinking, regulate their learning processes, and engage more meaningfully with STEM content. However, the relatively small effect size indicates that scaffolded metacognitive activities should not be used in isolation but rather integrated with other supportive instructional strategies to maximize their impact on students' learning outcomes.

Conclusion

This research study has found that scaffolded metacognitive activities positively influence the metacognitive awareness and self-regulation of students in the STEM subjects significantly. The effectiveness of the scaffolded learning environment was confirmed by the fact that students who had gone through the scaffolded learning process showed high levels of metacognitive awareness and self-regulation. Moreover, the research finds out that it is possible to integrate scaffolded metacognitive strategy into the STEM curriculum, but it must be supported by adequate resources, teacher readiness, and curriculum alignment at the system level in order to be implemented successfully. The results of the study are consistent with the literature and highlight the value of scaffolding in the development of higher-order thinking and self-regulation

Recommendations

Recommendations are drawn based on the findings of this study as follows:

i. Osun State Ministry of Education is to strive to incorporate scaffolding activities in metacognitive activities in the secondary school curriculum in STEM subjects. This may be provided by revisiting the current curriculum and providing clear instructions on the application of these strategies to be used by teachers.
ii. Future research would be conducted to understand the long-term effects of scaffold metacognitive activities on STEM performance in students. Also, the same research could be performed in other parts of Nigeria as it would be possible to compare the findings and also have more generalized results.
iii. Teachers should be provided with workshops and other training programs to enable them implement metacognitive strategies effectively. Educators should know how to scaffold student learning, facilitate reflection and aid self-regulation.
iv. An adequate supply of resources, including technologies and materials that facilitate scaffolded learning should be given to schools. This may involve technology of reflection, formative assessment systems and problem solving technology.
v. Education policy makers and curriculum designers need to integrate scaffolded metacognitive activities in STEM education to support cognitive and metacognitive learning in learners. It is possible through formulation of uniform systems where scaffolded instruction is incorporated in the instructional approach.

Limitations of the Study

Although this study offers strong perspectives in the efficiency of scaffold metacognitive activities in STEM learning, it is important to mention that the research has a number of limitations. The results are carried out by using non-equivalent groups, which may limit their applicability. The randomized controlled trials may be possible to confirm the results in future research. The sample size of 120 students is quite small, which might fail to represent all the variation in the experience of students in Osun State and their results. It is suggested that larger-scale studies should be used to confirm the findings. It is possible that the scaffolded metacognitive activities might not have had their full impact due to a short period of the intervention. Better evaluation of the lasting impacts of these strategies could be undertaken in longer-term studies.

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INCIDENTAL ECTOPIC PREGNANCY WITH VIABLE FETUS

BY

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Abstract
Ectopic pregnancy is the implantation of fertilized ovum outside the uterine cavity. The commonest ectopic location is the ampulla of the fallopian tube. Patients often present with abdominal pain, amenorrhea and vaginal bleeding. Abdominal ultrasound reveals an empty uterus and a complex adnexial mass with or without a live embryo. This study examined an incidental finding of ectopic pregnancy in a 39 year old female who presented for routine antenatal scan at 10 weeks of gestation with a live fetus. It was found that early presentation and prompt diagnosis is essential for timely management to prevent maternal mortality. Prognosis is related to maternal age, gestational age at presentation and onset of complications.

Keywords: Ectopic pregnancy, Amenorrhea, Abdominal pain, Adnexial mass

Introduction
Ectopic pregnancy occurs when a fertilized ovum implants outside the normal uterine cavity(Dupin et al., 2024; Jeffers et al., 2024; Jurkovic & Wilkinson, 2011; Kirk et al., 2013; Sivalingam et al., 2011), it is noteworthy that most of this ectopic gestation are found in the fallopian tube while others are found in the uterine cornu , ovaries, broad ligament, cervix, caesarian scar and abdominal cavity(Fylstra, 2012; Igwegbe et al., 2013; Jurkovic & Wilkinson, 2011; Pregnancy et al., 2020).
Factors associated with increased risk of ectopic pregnancy include assisted reproductive technique, untreated Chlamydia or gonorrhea cervicitis(Hoover et al., 2010), previous abortions, progesterone only pills, intrauterine contraceptive device, smoking, previous ectopic gestation, and previous caesarian section(Farren et al., 2026; Igwegbe et al., 2013; Jurkovic & Wilkinson, 2011; Sivalingam et al., 2011).
Tubal spasm, congenital defects of the fallopian tube, emotional factors, psychological factors and increasing maternal age over 35years are also significant predisposing factors to ectopic pregnancy (Di Gennaro et al., 2022; Igwegbe et al., 2013; Stabile et al., 2024). The index case is 39years old.
The prevalence of ectopic gestation is 1-2% worldwide(Jurkovic & Wilkinson, 2011), while in Nigeria the incidence ranges between 1.2-2.7% of deliveries and peak age incidence was found to be between 26-30years(Panti et al., 2012).
The presentation of ectopic pregnancy particularly tubal gestation can be acute, acute on chronic or chronic, although the chronic type is more common , the acute form tends to receive more attention because of the manner of presentation of the patient(Dhanju et al., 2023; Panti et al., 2012; Pregnancy et al., 2020; Rodgers et al., 2024). The index case presented more as an acute on chronic.
Though transvaginal ultrasound is the modality of choice for diagnosing ectopic pregnancy, it was however the

transabdominal route that was used in the index case to diagnose the ectopic gestation. This case is being reported because of the maternal age, mode of presentation and method of diagnosis.

CASE REPORT

Mrs A.Y is a 39 year old business woman who presented to the radiology department for an abdominopelvic ultrasound scan. She was referred from the obstetric and gynaecology clinic on account of lower abdominal pain and amenorrhea of about 10 weeks from her last menstrual period.

She has four children who are alive and well. The index pregnancy is her 5th pregnancy of which she was not aware. There was no history of pelvic infection, previous miscarrige, no history of abortion or previous curretage and dilation in the past. Also there was no history of previous abdominal surgery or ectopic gestation in the past.

Patient is conscious well oriented in time, place and person, not pale, afebrile, acyanosed, and no pedal edema.

Cardiovascular examination: blood pressure -126/70 mmHg, pulse rate:83 bpm regular with good volume; Respiratory examination: 22cpm with vesicular breathsounds;

Abdominopelvic examination: soft and moves with respiration, no palpable organ enlargement, mild tenderness in the suprapubic region and right iliac fossa.

A working diagosis of ongoing cyesis based on her last menstrual period was made and some investigations were requested.

Abdominopelvic ultrasound, full blood count, electrolyte/urea/creatinine and fasting blood sugar were expected to be presented by the patient for further review and management.

Pelvic ultrasound shows a bulky and empty uterine cavity with a right adnexial mass and fluid collection in the pelvis (Figure 1). Figure 2 shows measurement of the empty uterine cavity with a live fetus with cardiac activity within a right adnexial tubal ring, while figure 3 shows measurement of fetal crown rump length of 3.34 cm at 10 weeks 2 days gestational age.

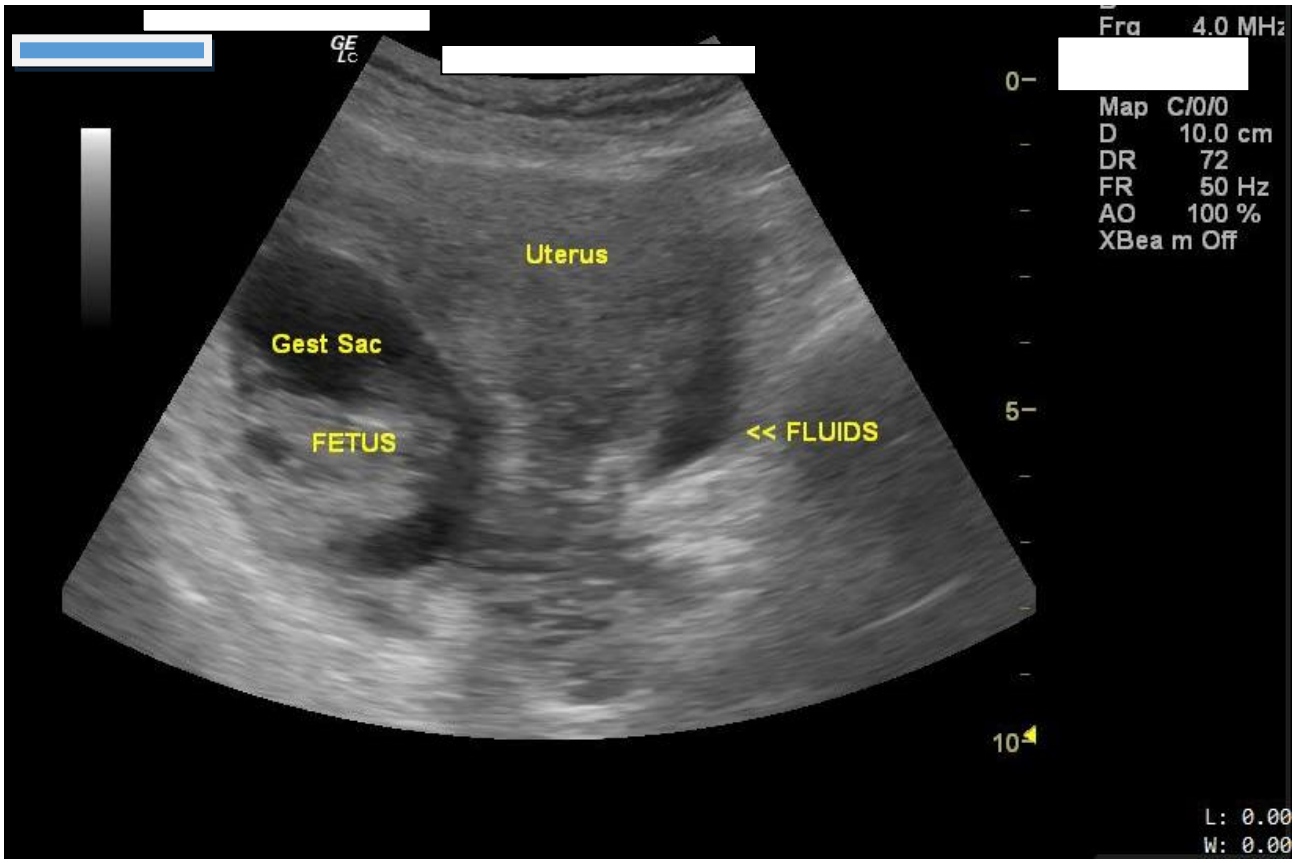

Figure 1: Pelvic ultrasound shows a bulky and empty uterine cavity with right adnexial mass and fluid in the pelvis

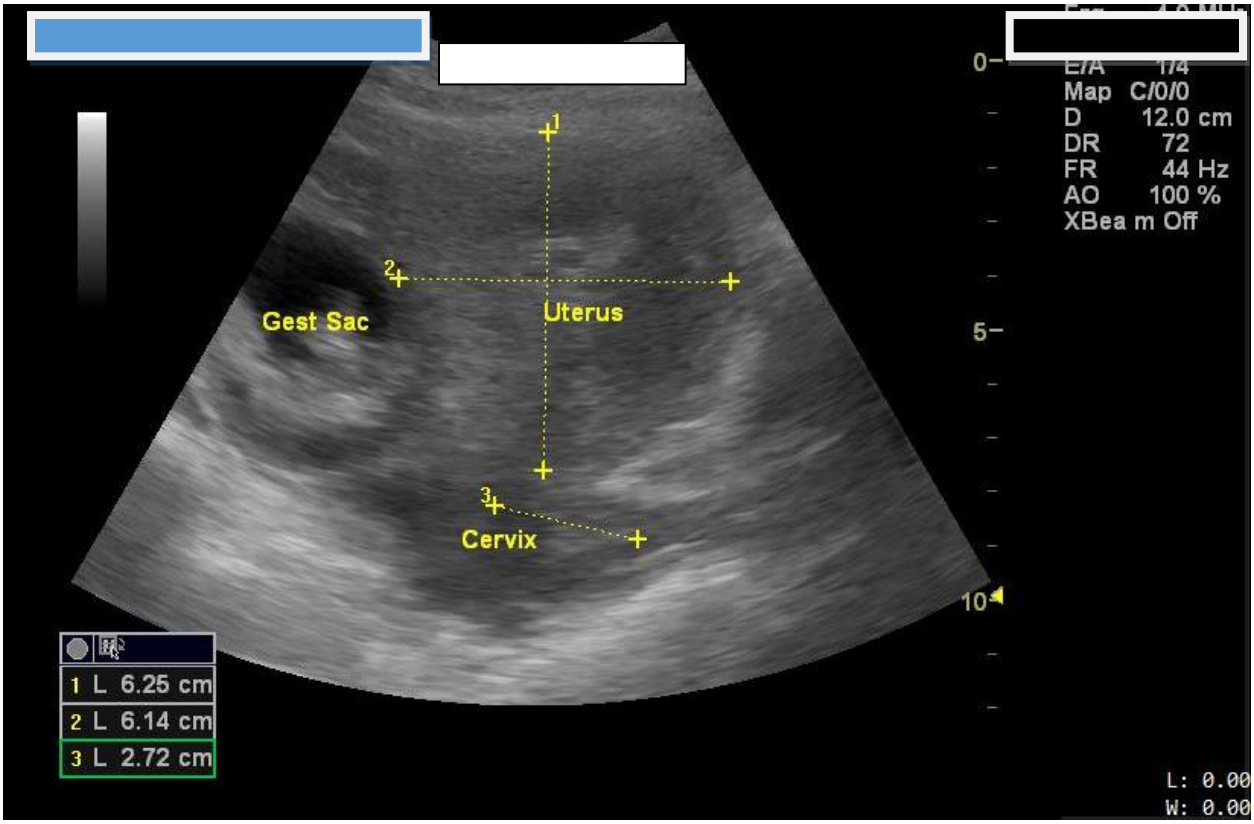

Figure 2: Pelvic ultrasound showing measurement of empty uterus and a right adnexial gestational sac with a live fetus with cardiac activity

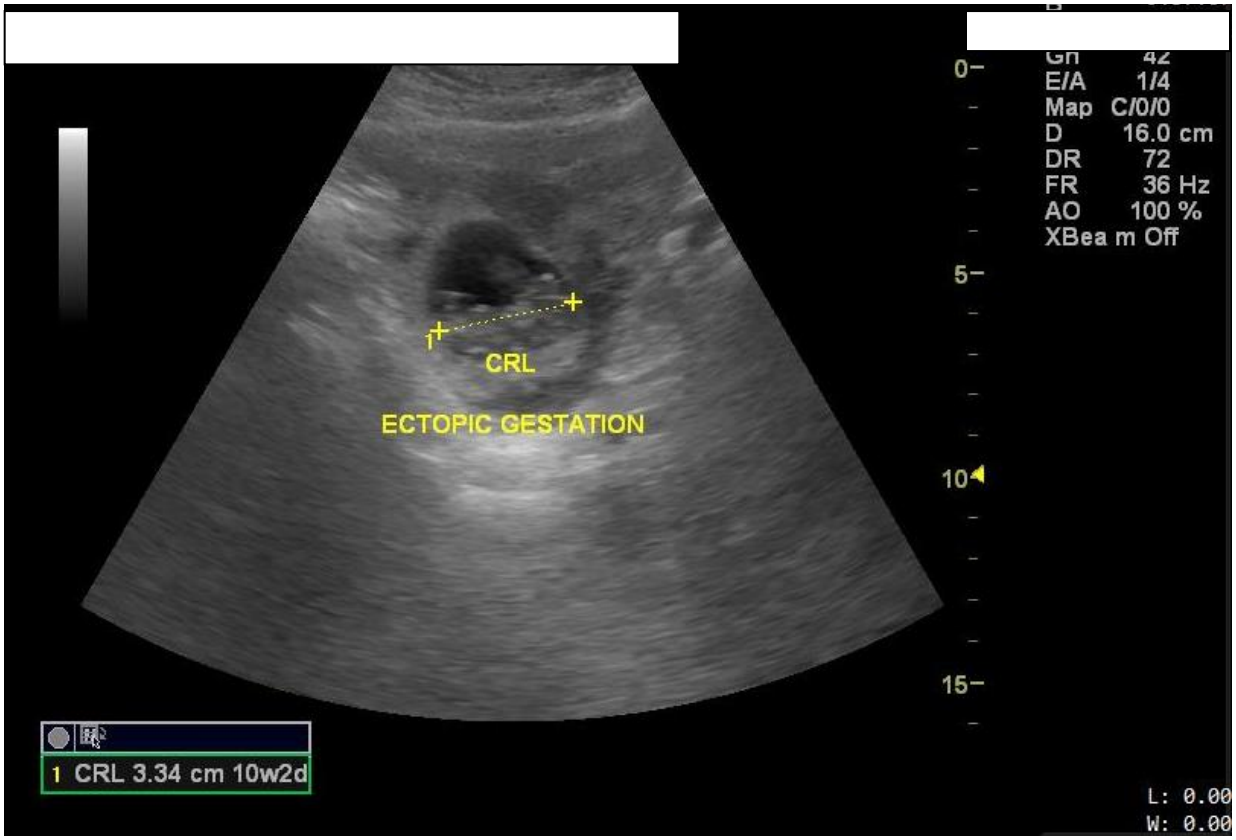

Figure 3: Pelvic ultrasound showing the fetal crown rump length (CRL) measurement of 3.34 cm with gestational age of 10weeks 2days.

DISCUSSION

Ectopic pregnancy is a significant cause of morbidity and mortality in women of reproductive age in developing countries especially sub-saharan region of Africa(Igwegbe et al., 2013; Sivalingam et al., 2011). Ectopic pregnancy is a common life threatening emergency in pregnancy and the leading cause of death in first trimester of pregnancy(Dick et al., 2025; Panti et al., 2012), and about 10% of women admitted with ectopic pregnancy in developing country eventually die from the pregnancy(Jeffers et al., 2024; Sivalingam et al., 2011).

The pathophysiology of ectopic gestation is variable and ultimately determines the location of the gestation. Fallopian tube dysfunction which could be anatomical or functional may result in impaired tubular motility, and ciliary dysfunction causing changes in the tubal environment and embryo arrest within the fallopian tube(Jeffers et al., 2024; Kirk et al., 2013; Shaw et al., 2010; Taran et al., 2015).

The fallopian tube ectopic gestation is the most common, however other ectopic site gestation occurences are rare and found to be associated with higher mortality and morbidity because they are often difficult to diagnose and present late with rupture(Dhanju et al., 2023; Jurkovic & Wilkinson, 2011).

The symptoms of ectopic pregnancy are non specific and often difficult to differentiate from other gynaecological, genitourinary and gastrointestinal symptoms such as salpingitis, miscarriage, adnexial torsion, corpus luteal cyst rupture, urinary tract infection and appendicitis(Farren et al., 2026; Kirk et al., 2013).

The clinical presentation varies, though commonly the triad of abdominal pain, vaginal bleeding and amenorrhea are found in majority of women with ectopic

gestation(Di Gennaro et al., 2022; Kirk et al., 2013; Panti et al., 2012). It is worthy to note that many women with ectopic pregnancy have no identifiable risk factors and those with a risk factor have no ectopic pregnancy and a third of women with ectopic pregnancy have no clinical signs and about ten percent have no symptoms(Farren et al., 2026; Kirk et al., 2013). The index patient presented with lower abdominal pain and amenorrhea.

Diagnosis with transvaginal ultrasound and quantitative serum b-human chorionic gonadotropinn is possible when patient present early (Igwegbe et al., 2013; Lin et al., 2021). Transvaginal ultrasonography is the primary diagnostic tool for clinically stable women with suspected ectopic pregnancy(Dick et al., 2025; Kirk et al., 2013).

The serum b-human chorionic gonadotropin(b-HCG) has a wide variation in its level in patient with ectopic gestation from less than 10mIU/ml to greater than 100,000mIU/ml(Frates et al., 2014), in normal viable pregnancy the HCG level generally doubles within 48hours while ectopic pregnancy is generally associated with a rise of more than 66% or a fall of more than 13% from the baseline level in48hours(Rodgers et al., 2024; Taran et al., 2015).

There are some other findings suggestive of tubal ectopic pregnancy on ultrasound and these include endometrial thickness(figure 2), fluid within the endometrial cavity, free fluid in the pouch of douglas(figure 1), presence of echogenic fluid in the morrison's pouch, inhomogenous or a non cystic adnexial mass and empty extra uterine gestational sac, however a definite diagnosis of tubal ectopic pregnancy can be made when an extrauterine gestational sac containing a yolk sac or an embryo is visualised(Kirk et al., 2013; Lin et al., 2021). The index case was seen with an extrauterine embryo with demonstrable heartbeat (figures 2 and 3)

Diagnostic laparascopy can be used when ultrasound is inconclusive in suspected ectopic pregnancy(Sivalingam et al., 2011)(Bohiltea et al., 2021) while serum progesterone is >50ng/ml in viable pregnancy and endometrial biopsy can also be taken and analysed for the presence or absence of chorionic villi, the absence of chorionic villi in the presence of static b-HCG is suggestive of ectopic pregnancy(Rodgers et al., 2024; Sivalingam et al., 2011).

Magnetic resonance imaging is commonly used to give additional information to ultrasound, it can accurately localise the site of abnormal implantation and can distinguish ruptured and unruptured gestation as well as the hemorrhagic phase(Dick et al., 2025; Kıroğlu et al., 2013).

The management options for ectopic pregnancy depends on the presentation of the patient and these include expectant management, medical treatment, radical surgery(salpingectomy), conservative surgery(salpingostomy), and laparascopy(Di Gennaro et al., 2022; Fernandez et al., 2013; Van Mello et al., 2012).

Expectant management is used when initial b-HCG is <1000IU/L where some of this ectopic gestation resolve spontaneously through regression or tubal abortion without any sequelae to the patient(Mullany et al., 2023; Sivalingam et al., 2011).

Medical therapy has involved the use of different agents such as potassium chloride, uterine artery embolization(Ozen et al., 2022), hyperosmolar glucose, actinomycin-D, prostalglandins, mifepristone and methotrexate which are injected directly into the ectopic sac or systematically via oral, intramuscular or intravenous route (Di Gennaro et al., 2022; Panti et al., 2012), however methotrexate adminstered intramuscularly as a single dose protocol is the most widely used and successful medical therapy for ectopic pregnancy (Taran et al., 2015).

Conservative surgery(salpingotomy) is mainly used for patient with less tubal damage particularly nulliparous women(Igwegbe et al., 2013; Moirano et al., 2023). Surgery is the mode of treatment in cases of ruptured ectopic, haemodynamic instability and heterotropic pregnancy(Taran et al., 2015) and this can be achieved by open laparatomy or laparascopy depending on the surgical expertise of the surgeon, availability of appropriate equipment and clinical state of the patient(Igwegbe et al., 2013). The index case was counselled with the husband on the best line of management

and had radical surgery done. Patient was clinically stable and discharged home after 6days post operation.

The prognosis of tubal gestation as the pregnancy advances can either diminish in size and spontaneously resolve or increase in size and subsequently rupture with consequent maternal morbidity or mortality(Varma & Gupta, 2012). This why early diagosis(Stone et al., 2021) and prompt management is essential as was the case in the index patient

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ACADEMIC HARDINESS AS PREDICTOR OF PRE-SERVICE PRIMARY SCHOOL TEACHERS' LEARNING OUTCOMES IN MATHEMATICS IN SOUTH-WEST NIGERIA

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Abstract

The study examined the relationship between academic hardiness and pre-service primary school teachers' achievement and interest in Mathematics in South-West Nigeria. The study was a survey research and the sample comprised of 234 pre-service primary school teachers. The instrument used for data collection was a questionnaire titled "Academic Hardiness Scale (AHS)" with a reliability coefficient of 0.91. Two research questions were raised and answered in this study. Data collected were analysed using Pearson's product moment correlation (PPMC). The result of the findings revealed that the relationship between academic hardiness and pre-service primary school teachers' achievement in Mathematics was not significant while academic hardiness has significant relationship with interest in Mathematics. Based on the findings, it was recommended that the primary school pre-service teachers should be encouraged to develop hardy attitude in the face of academic challenges and the school management should improve the academic hardiness of pre-service teachers in order to create more interest in Mathematics.

Keywords: Hardiness, Pre-service teacher, Mathematics, Learning Outcomes, Interest

Introduction

Mathematics is a discipline that has been gaining prominence in various areas, particularly scientific and technological development. It is relevant to fields of engineering, medicine, natural sciences and social sciences among others. Sengul and Dagistan (2018) demonstrated that mathematical concepts and abilities are indispensable for comprehending and elucidating scientific phenomena and models. Amao, Oladapo and Ajani (2020) has acknowledged that Mathematics is a fundamental analytical tool for a variety of theoretical postulates in various disciplines, particularly those that are scientific in nature. Cresswell and Speelman (2020) observed that the acquisition and mastery of Mathematics enhance the ability to weigh evidence with impartiality, as well as to engage in analytical and abstract thinking.

The subject provides students with the necessary skills to develop reasoning skills, consistency and accuracy, which are essential in all aspects of life. Matsayi, Adamu and Garba (2020) argue that students will be better prepared to navigate the evolving environment of our contemporary era of science and technology if they possess a solid understanding of Mathematics. Therefore, the capacity to manage an increased amount of learning Mathematics enhances learners' prospects for social advancement.

While Mathematics equips students with the necessary skills to excel in a variety of disciplines, it is not only crucial for academic success but also for the efficient operation in daily life (Alenka, Janja, Gregor and Anja, 2020). Therefore, Mathematics is a prerequisite for pursuing higher education in the majority of professions, such as finance and programming (Yesuf, Kebede, Zewdu, and Gebru, 2023). The value of Mathematics is substantial and its applications are indispensable in all aspects of life (Acharya, 2017). Consequently, it is crucial that academic institutions prioritise and allocate sufficient attention to Mathematics education, beginning with primary school. This is due to the fact that Mathematics is a critical subject in primary schools and therefore, it is imperative that the teaching and learning of it be properly considered.

The primary school level of education is not only the foundation for subsequent levels of education; it is also considered the entryway to all higher levels of education, which are

necessary for the development of highly skilled professionals such as scientists, teachers and doctors, which are essential for the success of any nation, regardless of its size, wealth, or poverty (Ebolume, 2022). Intended to provide students with foundational literacy and numeracy abilities that are used in all subjects areas. The establishment of the cognitive, affective, and emotional development occurs during this stage of life (Owojori and Gbenga-Akanmu, 2021). The mathematical skills that pupils acquire in primary school are the foundational skills that underpin all higher-level Mathematics skills. They also contribute to the development of the concepts and reasoning strategies that are necessary for future learning (Phan, Trinh, Phuong, Cuong, Manh and Nguyen, 2021).

Given the significance of Mathematics education at the primary school level, it is imperative to allocate sufficient attention to the training of pre-service primary school teachers. This level of attentiveness result in personnel who are highly motivated and resourceful at the primary school level. The pre-service primary school teachers were expected to be prepared as generalists to work in primary schools by acquiring a basic understanding of all primary school subjects and the ability to effectively teach them. Therefore, pre-service primary school teachers education programmes should prioritize the development of teachers who could enhance the academic performance of their pupils. It is therefore imperative that teacher education programmes prioritize the improvement of pre-service primary school teachers' mathematical knowledge and abilities. Given that the quality of Mathematics education in primary schools is likely to be contingent upon the mathematical knowledge that the pre-service primary school teachers' obtained during pre-service training (Mapolelo and Akinsola, 2015). It is imperative to equip Nigeria College of Education students with the necessary knowledge and skills to effectively teach Mathematics in primary schools in order to enhance the quality of education in the field of primary school Mathematics (Kennedy and Odell, 2014). This is because the mathematical competencies of the pre-service primary school teachers are believed to be crucial in the process of identifying solutions to specific mathematical problems.

Despite the importance of Mathematics in schools for the social, economic, scientific, and technological advancement of a nation, students have encountered challenges in their achievement in this subject (Ayanwoye, Akinsola and Oyeniran, 2024 and Hughes, 2023). The weakness of pre-service primary school teachers in colleges of education training as generalists, as well as their absence of requisite skills and competence for teaching Mathematics has resulted in low achievement in Mathematics. Tonya, Lisa, Conoyer, Karyn and Lesley (2018) noted that pre-service primary school teachers have a limited comprehension of Mathematics and the necessary preparation to effectively teach it. Additionally, research has demonstrated that the performance of pre-service primary school teachers' in colleges of education was subpar in the field of Mathematics (Ji-won and MiYeon, 2021; Xinrong, Gabriele, Johannes and Sigrid 2020).

Furthermore, this investigation is equally concerned with the interest of pre-service primary school teachers in Mathematics. Owora and Chika (2019) defined interest as the desire to learn or understand a subject, person, or condition, as well as the inclination to become engrossed in an experience and to persist in it. According to Okeke, Egara, Orga, and Nzeadibe (2023), interest is the enthusiasm of students to focus on a subject from which they derive some enjoyment. A student who is interested in Mathematics may devote more time to the subject. According to Azmidar, Darhim and Dahlan (2017), students who demonstrate a strong interest in Mathematics are more inclined to engage actively in the learning process and exhibit a high level of curiosity. Consequently, it is imperative for educators to guarantee that students' interest for Mathematics is maintained, realizing that students' interest in Mathematics yields high academic performance and vice versa. According to Suhaizal, Ana, and Danakorn (2021), interest is a critical element in the teaching and learning process and has been identified as a factor associated with achievement in Mathematics.

Researchers in the field of Mathematics education have conducted a variety of studies to enhance the teaching and learning of Mathematics by investigating possible factors that influence the learning outcomes of students in Mathematics. For example, prior research has concentrated on student-related factors (Kumah and Wonu, 2022), school-related factors (Onderi, *et. al*, 2015), psychological factors (Fehintola and Oyama 2021; Amao, Oladapo and Ajani 2020). The factor selected in this study is of paramount significance, as it is likely to inform their future classroom practice in addition to the implications for the identified learning outcomes in Mathematics

Hardiness is the capacity to endure stressors and maintain a positive attitude in the face

of adversity. According to Lwin and Myo (2020), hardiness is the capacity to effortlessly adjust to unforeseen changes, as well as a sense of purpose in daily life and personal control over one's existence. Maddi (2013) posited that individuals who endure a high level of stress without developing illness possess a personality structure that distinguishes them from those who becomes sick as a result of stress. Academic hardiness is a personality trait that is indicative of students' capacity to cope with and respond to academic work that is taxing. The concept of academic hardiness is concerned with the students who maintain a relatively high level of health despite the significant amount of stressful academic labour they undergo. Students' responses to academic work, both personally and professionally, are indicative of academic hardiness. Students who exhibit high levels of academic hardiness are more likely to persevere in the face of adversity and accomplish their goals. Kamtsios and Bartone (2021) proposed that academic hardiness enables pre-service teachers to leverage their prior experiences to confront the challenges and obstacles they encounter in college, transforming them into opportunities for development, and to endure the stress that results from their studies. It is characterized by the tendency of pre-service teachers to be profoundly engaged, with a desire to learn from experience and a need to be in control, irrespective of the results.

Edgargo (2018) defines academic hardiness as the ability to cope with three indices, challenge, control, and commitment. A commitment is a demonstration of one's dedication to their task. Regardless of the level of stress, pre-service primary school teachers who are profoundly committed to and engaged in their studies decide to remain engaged rather than withdraw. Additionally, students who are adept at commitment, which is associated with academic discipline and diligent academic work, prioritize academics (Pratama, Ahman, Machmud, and Dahia, 2023). Control is the degree to which pre-service primary school teachers exerts its influence on academic work to guarantee a positive outcome, regardless of the level of difficulty and tension involved. In an investigation of the correlation between Mathematics anxiety and performance in Mathematics, Zhang, Zhao and Kong (2019) discovered that academic hardiness was positively correlated with Mathematics achievement. Pratama, Ahman, Machmud and Dahia (2023) in their study 'academic hardiness, learning motivation, student learning outcomes in Indonesia' indicated that students' performance was significantly influenced by their academic hardiness. Qian and Wenxiu (2023) examined influence of hardiness on academic achievement of university students. They found a robust correlation between the academic hardiness of university students and their academic success. Furthermore, Kamtsios and Bartone (2021) conducted a preliminary assessment of the psychometric properties of the "Hardiness-Resilience Gauge" on an undergraduate sample. The study's results indicate that academic hardiness, a personality trait, is associated with the academic performance of undergraduate and student populations.

Edgardo (2018) discovered in his research on Students' Motivational Beliefs, Values, and Goals as Related to Academic Hardiness: Implications for Mathematics Teaching and Learning that the identified motivational constructs and students' Academic Hardiness have a significant positive correlation. This highlights the respondents' interest in Mathematics and their recognition of the subject's significance in their preparation for lifelong learning. Kamtsios and Karagiannopoulou (2011) corroborates this assertion, asserting that students with academic hardiness possess personality traits that distinguish them from those who refrain from attempting difficult academic coursework. Learners who demonstrate a strong commitment to Mathematics can convert challenging learning scenarios into opportunities for development. In light of this, the primary objective of this study is to determine if academic hardiness predicts pre-service primary school teachers' achievement and interest in Mathematics.

Research Questions

1. What is the relationship between academic hardiness and pre-service primary school teachers' Achievement in Mathematics?
2. What is the relationship between academic hardiness and pre-service primary school teachers' Interest in Mathematics?

Methodology

The study adopted a descriptive survey research design. The population of the study comprised all 200 level pre-service primary school teachers in colleges of education in South-west Nigeria. The sample used for this study was two hundred and thirty four (234) pre-service primary school teachers using simple random sampling technique. The instrument used for data collection was the questionnaire titled

"Academic Hardiness Scale. The researchers personally administer the questionnaire to the students. Face and content validity of the instrument was ascertained by the experts while Cronbach Alpha used yielded a reliability coefficient 0.91. The data collected were analysed using the Pearson's product moment correlation (PPMC).

Results

Research Question 1

What is the relationship between academic hardiness and pre-service primary school teachers' Achievement in Mathematics?

Table 1: Relationship between Academic Hardiness and Pre-service Primary School Teachers Achievement in Mathematics

Variables	N	r	Sig	Remark
Academic Hardiness	234	-0.070	0.266	N. S.
Achievement in Mathematics	234			

N.S denotes not-significant at $p<0.05$ level of significance

Table 1 indicates that the relationship between academic hardiness and pre-service primary school teachers achievement in Mathematics was negative, weak and not significant ($r=-0.070$; $p>0.05$). This implies that academic hardiness is not related to pre-service primary school teachers achievement in Mathematics.

Research Question 2

What is the relationship between academic hardiness and pre-service primary school teachers' Interest in Mathematics?

Table 2: Relationship between Academic Hardiness and Pre-service Primary School Teachers Interest in Mathematics

Variables	N	r	Sig	Remark
Academic Hardiness	234	0.242	0.000*	Sig.
Interest in Mathematics	234			

* denotes significant at $p<0.05$

Table 2 indicates that the relationship between academic hardiness and pre-service primary school teachers interest in Mathematics was positive, not very weak and significant ($r=0.242$; $p<0.05$). This implies that as the academic hardiness of pre-service primary school teachers developed, there will be significant increase in their interest in Mathematics.

Discussion

The result indicated that academic hardiness had no significant relationship with achievement in Mathematics of pre-service primary school teachers. This means that academic hardiness changes do not reflect on the achievement in Mathematics. The findings of the study is consistence with Liao, Chen, Chang and Chan (2017) who found no relationship between academic hardiness and Mathematics achievement among middle school students in Taiwan. Also, Bansal and Pahwa (2015) found no relationship between academic hardiness and academic achievement of secondary school students in Chandigarh. On the contrary, it is not in line with the findings of Qian and Wenxiu (2023) who reported significant relationship between hardiness and academic achievement of university students. Pratama, Ahman, Machmud and Dahia, (2023) found out that academic hardiness had a positive effect on student learning outcomes in Indonesia. Moreover, Kamtsios and Bartone (2021) study shows that academic hardiness is related with undergraduates' performance.

The findings indicated that the relationship between academic hardiness and interest in Mathematics is positive, not very weak and significant. This means that increasing academic hardiness would lead to a slight increase in interest in Mathematics. This finding is in agreement with Edgardo (2018) who found that students' academic hardiness have significant positive correlation with interest in Mathematics. This acknowledge the importance of the subject in their preparation to life-long learning. Students who can influence their learning will be committed, arouse their interest, have competence in the subject, and also will be engaged and challenged in doing difficult mathematical tasks.

Conclusion

Pre-service primary school teachers possess academic hardiness. Academic hardiness contributed to interest in Mathematics. Also, the findings of the study enable the researcher to conclude that there is no

significant relationship between academic hardiness and pre-service primary school teachers achievement in Mathematics.

Recommendations

1. Pre-service primary school teachers should be encouraged to develop hardy attitude in the face of academic challenges.
2. The school management should help to improve the academic hardiness of pre-service primary school teachers in order to create their interest in Mathematics.
3. Stakeholders should design training programmes on hardiness for students in colleges of education such that lecturers support them in practising problem-solving coping so as to improve their achievement in Mathematics.

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THE IMPACT OF COVID-19 PANDEMIC ON STUDENTS' ACADEMIC PERFORMANCE IN SECONDARY SCHOOL PHYSICS IN EKITI STATE, NIGERIA

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Abstract

This study examined the impact of COVID-19 Pandemic on students' learning outcomes in Secondary School Physics in Ekiti State, Nigeria. The study adopted the descriptive survey and expo facto design. The population of the study consisted all the public Senior Secondary School Three (SSS III) Physics students who sat for WAEC in all the 205 public secondary schools spread across the 16 local government Areas of Ekiti State. The sample for this study was 966 students selected from six secondary schools across the state. Multi-stage procedure which involved, simple random and stratified sampling techniques was used to select sample for the study. The instrument tagged pro-forma was used for data collection of the study. The instrument was validated by experts. Using descriptive and inferential statistics, the data gathered were analysed. The descriptive statistics of frequency counts, percentages, mean and standard deviation were used to answer the research questions while the inferential statistics involving t-test and Analysis of Covariance (ANCOVA) were used for testing the hypotheses. All the hypotheses were tested at 0.05 level of significance. The finding of the study revealed that students' performance in Physics was noticeably higher before the arrival of the Covid-19 pandemic than it was after the pandemic. This might be as a result of the senior secondary school student's inability to continue with the learning activities and they could not get support from their teachers during the school closure due to Covid-19 pandemic. Also, the study revealed that there is no significant difference between male and female students' performance in Physics before and after the lockdown due to covid-19 pandemic. Based on the finding of the study it was recommended that Physics teachers should ensure that students are involved learning activities even when there is extended length of time when students are not in school, such as during long vacations. Also, students should be encouraged by parents and teachers to get involved in the learning of Physics beyond the four wall of the classroom most especially when they are on long holiday.

Introduction

The COVID-19 pandemic caused unprecedented disruption to education systems worldwide, leading to prolonged school closures that affected over 1.6 billion learners across more than 190 countries. These disruptions significantly altered teaching and learning processes and raised global concerns regarding learning

loss and widening educational inequalities (Donnelly & Patrinos, 2022; Hammerstein et al., 2025). Evidence from international large-scale studies indicates that students experienced measurable declines in academic achievement following school closures, with average learning losses equivalent to several months of schooling (Betthдuser et al., 2024).

Science education is particularly vulnerable to instructional disruption because it relies on continuous engagement, experimentation, and practical activities that are difficult to replicate in remote learning environments. During the pandemic, many schools—especially in developing countries—were unable to transition effectively to online learning due to limited technological infrastructure, poor internet connectivity, and inadequate teacher preparedness (Angrist et al., 2025). Consequently, students in public schools experienced reduced instructional time, limited feedback, and diminished academic motivation.

In Nigeria, pre-existing challenges in physics such as inadequate laboratories, insufficient instructional materials, and overcrowded classrooms already contributed to persistent underachievement. The COVID-19 school closures compounded these issues, restricting access to hands-on learning experiences and structured academic support (Awofala & Lawal, 2023). Empirical studies have shown that learning disruptions disproportionately affected students in low-resource settings, widening achievement gaps and reducing overall performance levels (Peters et al., 2024).

Although emerging studies have examined COVID-19-related learning loss globally, limited research has used standardized examination data to quantify its impact within the Nigerian physics context. Therefore, this study investigates the effect of COVID-19 school closure on students' academic achievement in physics, providing empirical evidence to inform educational recovery strategies and policy interventions.

Statement of the Problem

Stakeholders in Nigerian secondary schools are outraged by the rising failure rate and lack of enthusiasm in science, particularly physics. In Nigeria, students who want to pursue a degree in science must offer physics in secondary school. In addition, admission into most science and technology-based programs requires at least a pass in Physics on the senior secondary certificate examination and the undergraduate entrance exam in this subject.

2020 saw the declaration of Covid-19 as a pandemic, a disease caused by a coronavirus that has spread around the world. More than one million people from both developed and developing nations died as a consequence of this terrible disease. When the virus is isolated from the host, it may be decreased and eliminated. Policies of social and economic segregation are counterproductive. This caused governments throughout the globe to declare lockdowns that varied from partial to complete lockdown.

It was observed that schools in Nigeria were shut down as a result of this lockdown, from elementary to university levels. Schools in the country were closed to curtail the spread of the deadly virus COVID-19. The schools were closed when students, particularly the certificate classes were preparing for the external examination for about six months (March to October 2020). Students were isolated from the daily school routine learning; during this period, many students took a break from learning and could not access online classes, which became the new order of learning during the period. These are some of the main reasons that motivated the researcher to investigate the impact of COVID-19 Pandemic on students' learning outcome in Secondary School Physics in Ekiti State, Nigeria.

Purpose of the Study

This study examined the impact of COVID-19 Pandemic on students' learning outcome in Secondary School Physics in Ekiti State, Nigeria. Specifically, the study:

i. examined secondary school students' performance in Physics before the emergence of Covid-19 pandemic;
ii. determined the impact of Covid-19 pandemic on secondary school students' performance in Physics after the lockdown due to Covid-19;
iii. examined the difference in male and female students' performance in Physics before and after the lockdown due to Covid-19.

Research Questions

The following research questions were raised for the study:

i. What is the academic performance of students in Physics before the lockdown due to Covid-19 pandemic?
ii. What is the academic performance of students in Physics after the lockdown due to Covid-19 pandemic?

Research Hypotheses

i. There is no significant difference in the academic performance of secondary school students in Physics before and after the lockdown due to Covid-19 pandemic.
ii. There is no significant difference between male and female students' performance in Physics before and after the lockdown due to Covid-19 pandemic.

Delimitation of the Study

This study was delimited to the impact of COVID-19 on students' learning outcome in Secondary School Physics in Ekiti State, Nigeria. The focus of the study was on the Senior Secondary School Three (SS III) students offering physics in public secondary schools in Ekiti State, Nigeria. The study was also delimited to one learning outcome; academic performance. Also, the study was delimited to gender as the extraneous variable that could influence students' performance in physics.

Methodology

This chapter presents the research design, population, sample and sampling techniques, research instruments, validity of the instruments, reliability of the instrument, administration of the instrument, and data analysis.

Research Design

The study is descriptive research that adopted expo facto designs. Expo facto is considered because the results of students in west African Examination Council (WAEC) examinations sat for before and after the Covid-19 pandemic which cannot be manipulated were used. The researcher does not have direct influence on the independent variable/s. The expo facto was employed to obtain the Physics Grade Point (PGP) of the students which exist in the schools selected for the study.

Population

The population for the study comprises all the public senior secondary Three (SS III) Physics students who sat for WAEC in all the 205 public secondary schools spread across the 16 local government Areas of Ekiti State in the 2018, 2019, 2021 and 2022. The students in senior secondary three (SS III) were preferred for the survey because they have spent reasonable number of terms in senior secondary school before setting for the WAEC examination.

Sample and Sampling Techniques

The sample for this study consisted of 966 students results of two years before and two years after Covid-19 selected from six secondary schools across the state. The schools were chosen from the three senatorial districts of Ekiti State using a multi-stage sampling procedure. The first stage involved selecting one local government area from each of the three senatorial districts through simple random sampling, resulting in a total of three local government areas. In the second stage, two secondary schools were selected from each of the previously chosen local government areas, making a total of six secondary schools. The researcher employed a purposive sampling technique for the selection process, taking into account the requirement for the school to be a mixed-gender institution. Finally, the students who registered and sat for Biology in the SSCE were selected from each of the selected schools using purposive random sampling technique. This process ensured the inclusion of students who had Biology WAEC results from both genders.

The results of students who sat for the WAEC examination were obtained for four years, including two years before and two years after the COVID-19 pandemic. The years considered were 2018, 2019, 2021, and 2022. A total of 240, 242, 229, and 255 students were selected respectively from the six secondary schools, resulting in a total of 966 students' results being obtained from the selected schools. The students' grades in Physics were converted into grade points called Physics Grade Points (PGP), which were later used for data analysis.

Research Instrument

Physics Performance Pro-forma (PPP) designed by the researcher was used for collecting data for the study. The pro-forma was used for obtaining the Physics grades and gender of students whose WAEC grades were collected from the secondary schools sampled in Ekiti State. The grades obtained" were rated to obtain the Physics Grade Point (PGP); A1 was rated as 9piont, B2 as 8points, B3 as 7points, C4 as 6points, C5 as 5points, C6 as 4points, D7 as 3points, E8 as 2points, and F9 as 1point.

Validity of the Instrument

Experts in Physics education, Educational Psychology, test, measurement and evaluation and the researcher's supervisor certified the instrument for face and content validity. In addition, their suggestions were applied in restructuring the instrument used for the study.

Reliability of the Instrument

The study employs a proforma as its primary data collection instrument, eliminating the need to assess its reliability since it is utilized solely for gathering pre-existing data.

Administration of Instrument

The researcher was responsible for the administration of the instrument. The researcher visited the selected schools and used the pro-forma to collect data related to the gender and grades of students who sat for WAEC in 2018, 2019, 2021, and 2022.

Data Analysis

Data collected were analysed using appropriate descriptive and inferential statistics. The research questions were answered using mean, standard deviation and charts, while t-test and analysis of covariance (ANCOVA) were used to test the hypotheses. Hypotheses 1, was tested using t-test while hypotheses 2 was tested using ANCOVA. All hypotheses were tested at 0.05 level of significance.

Results

Research Question 1: What is the performance of students in Physics before the lockdown due to Covid-19 pandemic?

In answering the research question 1 raised for the study, the results of students in Physics before the Covid-19 pandemic were gathered, converted to grade points called Physics Grade Point (PGP) and analysed with the result presented in table 1.

Table 1: Academic Performance of students in Physics before the lockdown due to covid-19 pandemic

PGP	Frequency	Percentage	Mean	S.D.
9	0	0		
8	8	1.7		
7	16	3.3		
6	27	5.6		
5	54	11.2	**3.50**	**1.63**
4	146	30.3		
3	97	20.1		
2	68	14.1		
1	66	13.7		
Total	**482**	**100.0**		

Table 1 present the performance of students in Physics before the lockdown due to Covid-19 pandemic. It shows that none of the students had the grade point

of 9(A1), 1.7% of the students had grade point of 8(B2) in Physics, 3.3% had 7(B3), 5.6% had 6(C4), 11.2% had 5(C5), 30.2% had 4(C6), 20.1% had 3(D7), 14.1% had 2(E8) while 13.7% had 1(F9). Also revealed from the table is the mean grade point of 3.50 with the standard deviation as 1.63. Considering the usability of the grades in making academic progress or gaining admission into tertiary institutions, 47.6% had grades below the least credit (C6) which is the minimum grade required to gain admission into tertiary institution, these grades would not earn the students' academic progress. This is an indication that the performance of students in Physics before the lockdown due to Covid-19 pandemic is poor. The pattern of the performance is further explained in figure 1.1

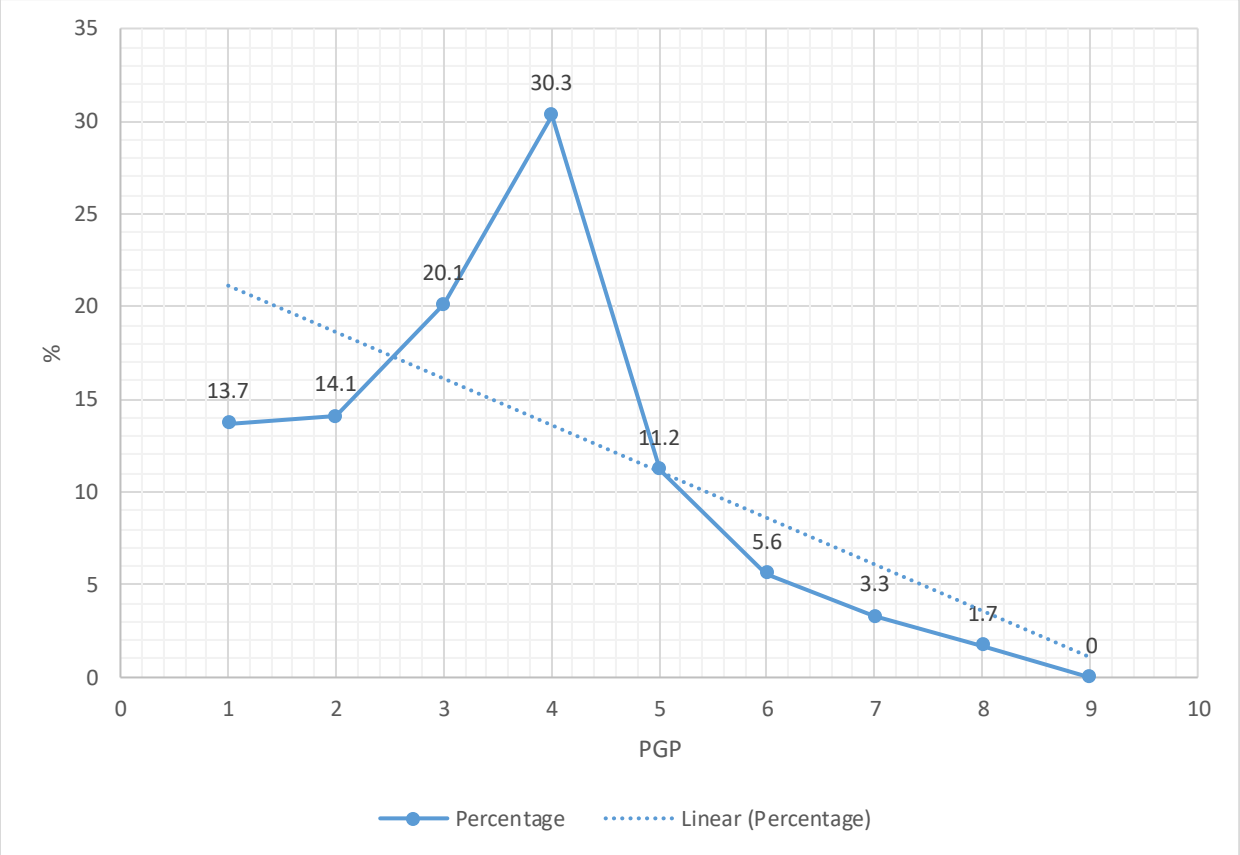

Figure 1.1: Graph showing the pattern of performance of students in Physics before the lockdown due to Covid-19 pandemic

Research Question 2: What is the performance of students in Physics after the lockdown due to covid-19 pandemic?
To answer research question 2 raised for the study, the results of students in Physics after the covid-19 pandemic were gathered, converted to grade points called Physics Grade Point (PGP) and analysed with the result presented in table 2.

Table 2: Performance of students in Physics after the lockdown due to covid-19 pandemic

PGP	Frequency	Percentage	Mean	S.D.
9	0	0		
8	6	1.2		
7	13	2.7		
6	34	7.0		
5	46	9.5	**3.25**	**1.70**
4	115	23.8		
3	97	20.0		
2	76	15.7		
1	97	20.0		
Total	**484**	**100.0**		

Table 2 shows the performance of students in Physics after the lockdown due to Covid-19 pandemic. It reveals that none of the students had the grade point of 9(A1), 1.2% of the students had grade point of 8(B2) in Physics, 2.7% had 7(B3), 7.0% had 6(C4), 9.5% had 5(C5), 23.8% had 4(C6), 20.0% had 3(D7), 15.7% had 2(E8) while 20.0% had 1(F9). Also, the mean grade point is 3.25 and the standard deviation is 1.70. Looking at the usability of the grades in making academic progress or gaining admission into tertiary institutions, 55.7% had grades below the least credit (C6) which is the minimum grade required to gain admission into tertiary institution, these grades would not earn the students' academic progress. This is an indication that the performance of students in Physics after the lockdown due to Covid-19 pandemic is poor. The pattern of the performance is further explained in figure 2.1

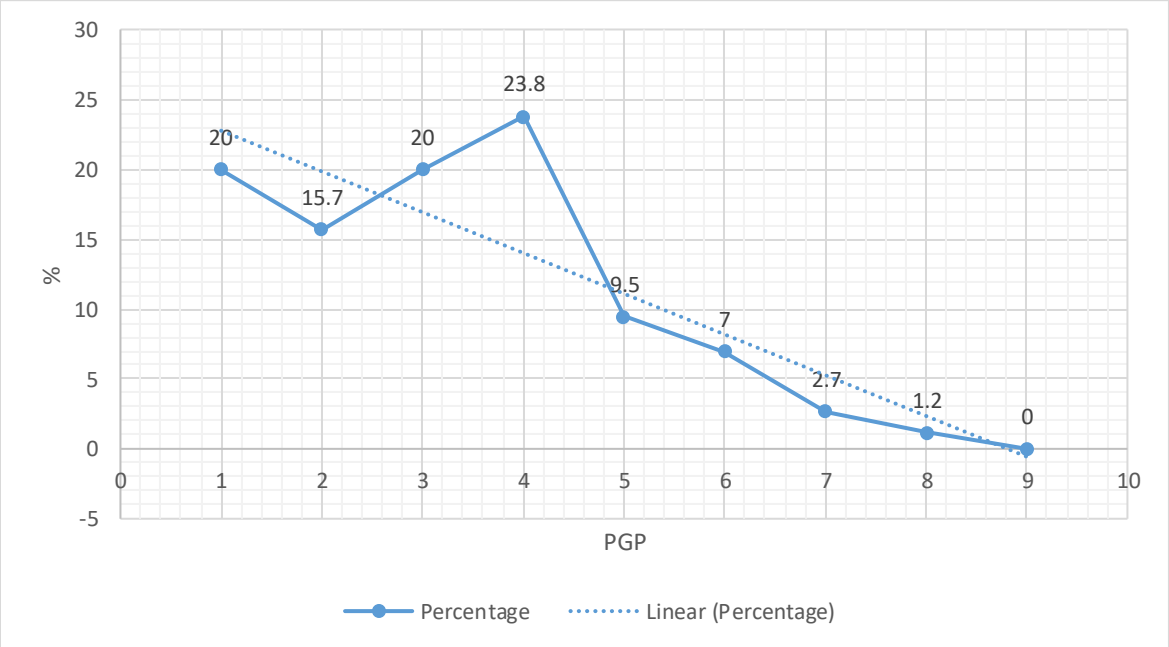

Figure 2.1: Graph showing the pattern of academic performance of students in Physics after the lockdown due to Covid-19 pandemic

Hypotheses Testing

Hypothesis 1: There is no significant difference in the academic performance of secondary school students in Physics before and after the lockdown due to covid-19 pandemic.

In testing the hypothesis, the Physics Grade Point (PGP) of secondary school students before and after the lockdown due to covid-19 pandemic were collected and afterward compared for statistical significance using t-test statistics at 0.05 level of significance. The result is presented in Table 3

Table 3: t-test analysis of academic performance of students before and after Covid-19 pandemic

Performance	N	PGP Mean	SD	df	t	P
Before Covid-19 Pandemic	482	3.50	1.63	964	2.333	.019*
After Covid-19 Pandemic	484	3.25	1.70			

*p<0.05

Table 3 shows the result of the t-test analysis of academic performance of students before and after lockdown due to Covid-19 pandemic. The result shows that before the Covid-19 pandemic the students had higher mean Physics Grade Point (3.500) on performance than after the covid-19 pandemic (3.25). It was further shown from the result that the computed t-value (2.333) with degree of freedom 964 was statistically significant at 0.05 level of significance as $p<0.05$. The null hypothesis was rejected. Hence, there is significant difference between the academic performance of secondary school students in Physics before and after the lockdown due to covid-19 pandemic.

Hypothesis 2: There is no significant difference in male and female students' performance in Physics before and after the lockdown due to covid-19 pandemic.

In testing hypothesis 2, the academic performance scores of male and female students in Physics before and after the lockdown due to covid-19 were collected and analysed for statistical significance using Analysis of Covariance (ANCOVA) statistics at 0.05 level of significance. The result is presented in Table 4.

Table 4: ANCOVA of Male and Female Students' Academic Performance before and after Covid-19 Pandemic in Physics

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	139.460[a]	3	46.487	17.562	.000
Intercept	10563.837	1	10563.837	3990.927	.000
COVID-19	14.108	1	14.108	5.330	.021
GENDER	124.753	1	124.753	47.131	.000
COVID-19 * GENDER	.085	1	.085	.032	.858
Error	2546.379	962	2.647		
Total	13674.000	966			
Corrected Total	2685.839	965			

a. R Squared = .052 (Adjusted R Squared = .049)
Dependent Variable: PGP

Table 4 shows that there is no significant difference between male and female students' performance in Physics before and after the lockdown due to covid-19 pandemic ($F_{1,536}=0.032$, $p>0.05$). The null hypothesis is not rejected. Similarly, the main impact of gender ($F_{1,536}=47.131$, $p<0.05$) on the academic performance of students is statistically significant at 0.05 level while the impact of Covid-19 ($F_{1,536}=5.330$, $p<0.05$) on the academic performance of students is statistically

significant at 0.05 level. It implies that with the lockdown due to Covid-19 pandemic, gender has no statistical impact on the academic performance of students in Physics.

Discussion

The findings of the study revealed that the students' level of performance in Physics was noticeably higher before the arrival of the Covid-19 pandemic than it was after the pandemic. Students were forced to take an unexpectedly long break from their studies owing to a lockdown that was implemented because of the Covid-19 pandemic. This is, without a doubt, one of the variables that could be accountable for the recent decline in students' academic performance. This finding is consistent with the submission of Mendoza-Lizcano *et al.* (2020), Engzell *et al.* (2020) and Abiona and Falebita (2020) that the academic performance of students in science has decreased since the outbreak of the Covid-19 pandemic.

It has been observed in alliance with the submission of Abiona and Falebita (2020) that most students in public secondary schools could not continue with the learning activities during the Covid-19 pandemic. This could be that most public secondary schools are not prepared and not having ICT facilities that could support the teaching and learning of Physics outside the school. Most students have lost the rhythm to learning due to the long break from academic activities and they are now struggling to gain the academic stamina needed for progressive academic performance.

The study revealed that significant difference exists between the academic performance of secondary school students in Physics before and after the lockdown due to covid-19 pandemic. Students had fallen out learning due to lockdown brought by Covid-19 pandemic. This was in agreement with Abiona and Falebita (2020) who came up with the conclusion from the study conducted on the impact of the covid-19 pandemic on senior secondary school student's academic performance that the covid-19 pandemic, which resulted in a long break and school closure, had a negative impact on students' performance.

The study revealed that there is no significant difference between male and female students' performance in Physics before and after the lockdown due to covid-19 pandemic. The main impact of gender on the academic performance of students is not statistically significant while the impact of Covid-19 on the academic performance of students is statistically significant. It is observed from the study that with the lockdown due to Covid-19 pandemic, gender has no statistical impact on the academic performance of students in Physics.

Summary

This study examined the impact of COVID-19 Pandemic on students' learning outcome in Secondary School Physics in Ekiti State, Nigeria. The study specifically examined secondary school students' performance in Physics before and after the emergence of covid-19 pandemic. The study Investigated the secondary school students' experiences in learning Physics during the lockdown due to covid-19 pandemic.

The study adopted the descriptive research that adopted expo facto designs. The population of the study comprises 12,585 students from all the public senior secondary school Three (SSS III) Physics students in all the 205 public secondary schools spread across the 16 local government Areas of Ekiti State. The sample for this study was 966 SSS III students selected from six (6) secondary schools across the state. Multi-stage procedure which involved, simple random and purposive sampling techniques was used to select sample for the study. The instrument tagged Physics Performance Pro-forma was used for data collection. The instrument was validated by experts and PPP had a reliability coefficient of 0. 731. Using descriptive and inferential statistics, the data gathered were analysed. The descriptive statistics of frequency counts, percentages, mean and standard deviation were used to answer the research questions while the inferential statistics involving t-test and Analysis of Covariance (ANCOVA) were used for testing the hypotheses. All the hypotheses were tested at 0.05 level of significance. The study revealed that:

i. students' performance in Physics was noticeably higher before the

arrival of the Covid-19 pandemic than it was after the pandemic.

ii. significant difference exists between the academic performance of secondary school students in Physics before and after the lockdown due to covid-19 pandemic.

iii. there is no significant difference between male and female students' performance in Physics before and after the lockdown due to covid-19 pandemic. The main impact of gender on the academic performance of students is not statistically significant while the impact of Covid-19 on the academic performance of students is statistically significant

Conclusion

On the basis of the findings of this study, it is concluded that the Covid-19 pandemic had impact on the secondary school students' performance in Physics. Gender does not have impact on the secondary school student's academic performance in Physics either before or after the lockdown" due to Covid-19 pandemic. However, male and female students differ in their experiences in learning Physics during the lockdown due to covid-19 pandemic.

Recommendations

Sequel to the findings of the study, the following recommendations were made;

1. Physics teachers should ensure that students are going through various learning activities even when there is extended length of time when students are not in school, such as during long vacations;
2. Teachers should adopt strategies that would motivate students to learn Physics so that they can improve learning outcomes in Physics;
3. Parent should create enabling environment for students to engage in the learning activities during the long vacation;
4. Government should create enabling environment for teachers to stay connected with the students even when they are on holiday by motivating the teachers and providing ICT infrastructures in school for use.

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EFFECTS OF AI INSTRUCTIONAL PLATFORM ON STUDENTS' ACADEMIC PERFORMANCE IN PHYSICS IN EKITI STATE SECONDARY SCHOOLS

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Abstract

The study investigated the effects of AI Instructional platform on students' academic performance in Physics in Ekiti State Secondary Schools. A quasi-experimental research design was employed for the study. The population comprised 11,603 Senior Secondary School two students from 202 public secondary schools in Ekiti State, Nigeria. A sample of 100 SS2 Physics students were selected through multistage sampling procedure. Data were collected using the Physics Performance Test (PPT). The instrument was validated by experts in Science Education, Ekiti State University, Ado Ekiti and yielded a reliability co-efficient of 0.78. The study lasted eight weeks, data obtained were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to answer research question while all hypotheses were tested using t-test at 0.05 level of significance. Findings of the study revealed that students taught with the AI instructional platform significantly performed better than those taught with the conventional method in Physics. It was recommended that Physics teachers should adopt AI instructional platforms such as Khan Academy to improve teaching and academic performance in Physics. Physics teachers should receive training on the use of AI and digital learning platform like Khan Academy to maximize their effectiveness and ensure successful implementation in classrooms. Also, Curriculum planners should consider integrating AI learning into the Physics curriculum to complement traditional teaching methods and encourage interactive, personalized learning experiences.

Keywords: Artificial Intelligence, physics, academic performance, AI Instructional platform, secondary school students

Introduction

In the constantly evolving landscape of education globally, technology played a pivotal role in transforming traditional teaching methods and enhancing students' learning outcomes. One of the most groundbreaking advancements is the integration of Artificial Intelligence (AI) into the field of education. Education is an avenue of training and learning especially in schools. The ultimate purpose of education is to empower an individual to excel in a chosen field of career, and to be able to positively impact his environment. Education is the process of facilitating learning, acquiring knowledge, skills, values, beliefs, and habits through teaching, training, research or self-study. It is a structured process that helps individuals develop intellectually, socially, and emotionally to function effectively in the society. Nigeria as a nation recognizes that education is a national activity which involves an orderly, deliberate and sustained effort to transmit or develop knowledge, concepts, skills and attitude or habits, hence her determination to provide lifelong education for her citizens (Badmos, Agbeti & Umeh, 2016, Ayeni, 2022).

Science is a systematic knowledge of the environment. It provides a body of knowledge for addressing various forms of human, material and environmental problems. Science can be viewed as composed of two major complementary modes, viz: accumulation of knowledge through exploration and discovery efforts about the natural world, and the use of such knowledge for human and material

development. Science and technology allow students to observe, collect evidence and draw inferences to arrive at solutions to problems. This helps students learn new content and solidify their understanding of previously learned concepts, ideas, and theories. As a result of science value and relevance to human civilization, it seems to be receiving more attention in the education system. People from all over the world are living in an age of science and technology, which has led to breakthroughs like gene therapy for blood cancer treatment and the use of CCTV cameras for security. In our current globe, all human activities and style of life are highly impacted by science since nature normally talks science every day (Omotayo, 2016).

Nigeria is a developing nation with an increasing demand for science-based skilled man-power. The attainment of this goal could be fostered through the acquisition and application of the enabling skills inherent in science subjects including Biology, Chemistry and Physics, beginning from the Secondary School level. The Science which aims at understanding the physical world we live in is called Physics (Adolphus, 2020).

Physics is an aspect of science that deals with physical phenomena of our world (Adedayo, 2016). Its role in the advancement of national growth in science and technology is germane. Physics as a field of study is critical in understanding the occurrences in the universe. This is because Physics is a physical science that deals with the world and everything that happens around us, especially as related to force, energy and motion (Adedayo & Akinbode, 2025).

Academic performance refers to students' achievement and success in the educational endeavours. It is typically measured by assessing students' grades, test scores, and overall academic accomplishments. It serves as an indicator of students' mastery of the subject, his ability to apply knowledge, and level of engagement in the studies. Teachers, parents and educational institutions use academic performance to identify areas of strengths and weaknesses, tailor instructional support and track students' progress over time.

Much as the role of Physics in the nation's technological development cannot jettisoned, it is disappointing to note that the academic performance of students in Physics, especially in external examinations, has been fluctuating over the years in Nigeria. Stakeholders such as teachers, parents, school administrators and policy makers in Nigeria's education system are very concerned about the inconsistency in the academic performance in Physics among students. Some of the issues found to be responsible for this inconsistencies have been traced to the abstract nature of Physics concepts, students attitude towards Physics, gender difference, school location, inappropriate teaching strategies and methods, inadequate facilities, lack of instructional materials, teachers professionalism, among others (Ayeni, Omotayo and Adedayo, 2016).

One major factor found to be responsible for the fluctuation in academic performance of students in Physics is the teaching methods employed by the teachers in the classroom (Adedayo, 2022; Adedayo & Ajayi, 2022). Over the years, the traditional methods of teaching have been the most used teaching methods in the teaching of Physics. These methods of teaching Physics may not always effectively convey the complex ideas in a way that resonates with students. Physics requires students to understand and apply complex mathematical equations, scientific principles, and theories, which can be challenging to grasp through traditional teaching methods alone. Currently, we live in a scientifically and technologically advanced society where students face difficulties and problems in subjects like Physics, mathematics, and other physical science related subjects. Therefore, there is a need for the introduction of more engaging teaching methods into the teaching of Physics such as, the Online Instruction, the use of AI instructional platforms, Computer Assisted Instruction, video based teaching, etc. The use of any of these methods will assist teachers in delivering Physics concepts in a more interesting way that will enhance their engagement and better understanding in Physics concepts. This is where AI instructional platform comes into play offering innovative solutions to make Physics more accessible and engaging for students towards enhancing performance in the subject.

AI, which is an acronym for Artificial Intelligence, is a field of study that explores how to make computers perform tasks that would typically require human intelligence, such as virtual perception, speech recognition, decision-making and language

understanding (Crawford, 2021). It is the use of intelligent machines, especially computers, to simulate human intelligence in machines that are programmed to think and mimic human actions. It is the branch of computer science, which makes the computers to mimic human behaviour to assist humans for better performance. AI Replicates human intelligence, solves knowledge-intensive tasks, builds machines, which can perform tasks that require human intelligence, creating some systems which can learn by itself. Machine learning and deep learning are two subsets of AI which are used to solve problems through high performance algorithms and multilayer neural networks, respectively.

The use of AI has become an inseparable part of human life. Various aspects of human life have been affected by the existence of AI developments ranging from individuals to government agencies and has influenced all spheres of human endeavours, education inclusive. The integration of AI technologies in education has advanced the transition of educational system from the ancient analog era to the digital world. Furthermore, with the recent developments in AI technologies, it is apparent that AI will continue to influence man's daily activity. In classroom teaching, AI has the potential to revolutionize the way students engage with educational contents, receive feedback, and ultimately improve their academic performances. The incorporation of AI in education has opened new possibilities for personalized and adaptive learning experiences for students.

AI systems can tailor instructional content to individual student needs, preferences, and learning styles. Platforms such as Khan Academy, Google Classroom, Coursera, penseum, Kira Learning, Labster among others are designed to meet individual student needs, optimize instruction, and improve academic performance. Khan Academy is an already existing online adaptive learning platform that uses a combination of human-created content and AI-powered tools to provide personalized learning experiences. Its primary AI feature is its "Khanmigo" tool, which provides personalized feedback and support to both teachers and students as they work through exercises, essentially acting as an AI tutor that can adapt to each student's learning pace and needs, offering hints, explanations, video contents and questions based on their progress and understanding. The video contents on the platform can be downloaded and watch on YouTube channel. This allows for a more customized learning experience compared to traditional educational contents. It makes use of AI technologies such as machine learning, deep learning, natural language processing, and computer vision. It provides several benefits such as personalized learning experiences, improves student's engagement, and enhances students' academic performance.

Statement of the Problem

Physics is one of the core science subjects in secondary school and serves as a foundation for many science and engineering-related disciplines. It plays a fundamental role in determining the scientific and technological capabilities of a nation. Physics remains a foundational subject in sciences, critical to technological advancement and innovations. However, despite its importance, the academic performance of secondary school students in physics over the years continued to fluctuate, as evidenced by the inconsistency in external examinations results such as West African Senior School Certificate Examination (WASCE). These fluctuations have raised serious concerns about the effectiveness of the conventional teaching methods and the overall learning experience of students in Physics. A lot of research attribute these performance challenges to various factors such as limited students' engagement, abstract content delivery, lack of real-world applications, inadequate instructional resources, students' attitude towards Physics, among others.

The conventional chalk-and-talk approach seems to be insufficient in addressing the diverse learning needs of today's students, many of whom thrive in interactive, technology-driven environments. There is the need therefore to attempt considering an instructional strategy that is technology based. In this regard, the upcoming Artificial Intelligence (AI) assisted instructional platforms could come to the mind for consideration. Artificial Intelligence (AI)-assisted instructional platforms have emerged as innovative platforms capable of transforming the teaching and learning process. These platforms offer personalized learning experiences, immediate feedback, adaptive learning and interactive simulations

that can make complex physics concepts more accessible and engaging.

Students today have become so vast in the use of technology to the extent that they search the internet for virtually every information they need. They no longer depend on the conventional method of instruction confined to the four walls of the classroom and explanations from their teachers alone. They could do their assignments using AI tools and platforms like Chat GPT, Meta AI, Perplexity AI, Khan Academy, etc. They go as far as getting more clarifications and detailed explanations on complex concept in physics which they may not understand in the class. Seeing how students are so interested in the use of AI platforms, tools, and techniques, the researcher thought it wise to go into this study to investigate if perhaps these AI tools and platforms that students are so interested in, could be annexed to influence their academic performance in Physics, especially the Khan Academy. This study therefore, investigated the effects of AI Instructional platforms such as Khan Academy on students' academic performance in physics.

Purpose of the Study

The main purpose of the study was to investigate the effects of AI Instructional Platform on Senior Secondary School Physics Students' academic performance in Ekiti State, Nigeria. Specifically, the study:

i. investigated the effects of AI instructional platform on students' academic performance in Physics.

Research Question

One research question was raised to guide the study:

1. Would the use of AI- instructional Platform influence students' academic performance In Physics?

Research Hypotheses

The following null hypotheses were formulated and tested for the study:

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

Methodology

The study adopted a quasi-experimental of pre-test post-test control group design. The population of the study comprised all Senior Secondary two Physics Students numbering 11,603 across the sixteen Local Government Areas in Ekiti State, Nigeria. The sample for the study was 100 Senior Secondary two (SS II) students selected from four Schools in Ekiti State. The sample was selected through multistage sampling procedure. At the first stage, one senatorial district was selected out of the three senatorial districts in Ekiti State using simple random sampling technique. The second stage was the selection of two Local Government Areas (LGAs) from the selected senatorial district using, simple random sampling technique. The third stage was the selection of two schools from each of the two Local Government Areas, using purposive sampling technique as a result of functional facilities needed. The study made use of one instrument tagged "Physics Performance Test" (PPT) designed by the researcher. The Physics Performance Test (PPT) contained items drawn from SS II Physics curriculum. The PPT consisted of two sections, Section A elicited information on the bio data of the respondents such as name of school, gender and local government. While section B contained 20 multiple choice items with four options (A-D). Items of the pre-test were re-arranged and administered as post-test to avoid hallow effect.

The instrument was subjected to face and content validity by expects in Science Education, Tests, Measurement and Evaluation in the Faculty of Education, Ekiti State University, Ado-Ekiti. The reliability of the instrument was determined through test re-test reliability method. The results obtained were subjected to Pearson's Product Moment Correlation analysis which yielded a reliability co-efficient of 0.78 which adjudged the instrument to be reliable. The data collected through the PPT were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to answer the research question. While all the hypotheses were tested using t-test at 0.05 level of significance.

Results

Research Questions 1: Would the use of AI Instructional Platform influence students' academic performance in Physics?

In answering this question, the physics students were exposed to AI-assisted instructional platform before treatment and data collected was exposed to descriptive statistics of mean and standard deviation. The result was presented in Table 1

Table 1: Mean and Standard Deviation of students' performance in Physics before and after exposure to AI Instructional platform and Conventional Method

Group	*N*	*Before*		*After*		*Mean Difference*
		Mean	*SD*	*Mean*	*SD*	
AI Instructional Platform	54	41.28	6.42	74.63	7.85	33.35
Conventional Method	46	40.87	6.11	58.94	8.27	18.07

The results in table 1showed that the experimental group improved from a pre-test mean score of 41.28 (SD = 6.42) to a post-test mean score of 74.63 (SD = 7.85), resulting in a mean difference of 33.35. The control group also moved from a pre-test mean score of 40.87 (SD = 6.11) to a post-test mean score of 58.94 (SD = 8.27), with a mean difference of 18.07. Although both groups improved after treatment, the improvement recorded by the experimental group was markedly higher. This shows that AI Instructional platform positively influenced students' academic performance in Physics.

Testing of Hypotheses

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

To test Hypothesis 1, pre-test mean scores of students in experimental and those in the control group were computed and compared for statistical significance using t-test at 0.05 level of significance. The result is presented in Table 2.

Table 2: t-test analysis of the academic performance of students in experimental and control groups before treatment

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Experimental	54	41.28	6.42	98	0.31	0.76
Control	46	40.87	6.11			

p>0.05

Table 2 showed the t value (98) = 0.31, p = 0.76 > 0.05, indicating no significant difference between the groups. Thus, the null hypothesis was not rejected. This confirms that both groups started with comparable performance levels, i.e. homogeneous. By implication, any post-test differences can be attributed to the treatment.

Hypothesis 2: There is no significant difference in the academic performance of students in experimental and control group after treatment.

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

Table 3: t-test analysis of the academic performance of students in experimental and control group after treatment

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Experimental	54	74.63	7.85	98	9.97	0.000
Control	46	58.94	8.27			

p<0.05

Table 3 presented the **t value (98) = 9.97 and p < 0.05,** indicating a significant difference between the groups, with the experimental group performing better, having a higher mean. This revealed that the AI Instructional platform had a positive and significant effect on students' academic performance in Physics.

Discussion

The study found that students taught with the AI instructional platform performed better in Physics than those taught using conventional methods. This aligns with the submission of Okoye, et al. (2024), that there was an improvement in students' performance through technology-enhanced learning. This might be the reason why Ukoh and Nicholas (2022), concluded that the teachers in Ibadan North Local Government Area supported the adoption of AI in Physics teaching. A likely explanation is that AI platforms offer interactive engagement and addresses individual learning gaps in Physics than the conventional methods. In contrast, conventional methods are often teacher-centered and less responsive to individual needs.

The finding of the study also showed that there was no significant difference in the academic performance of experimental and control groups before treatment. This baseline equivalence is crucial for attributing any post-treatment differences to the intervention itself rather than pre-existing disparities. This is in line with the observations of Oladipo and Adeyemi (2020), establishing similar starting points ensures that the effects of instructional innovations, such as AI-assisted platforms, can be evaluated more reliably. A plausible explanation is that students across both groups shared similar performance in Physics contents, teacher quality, and school resources, which minimized initial differences in academic performance. This is consonant with the finding of Chukwuma and Okechukwu (2021), who reported that pre-test equivalence between groups is common in well-designed experimental studies in Nigerian secondary schools and forms a sound basis for subsequent comparison. This baseline finding showed the methodological rigor of the study, ensuring that any observed improvements in performance following the treatment can be confidently linked to the AI instructional platform rather than other confounding factors.

The study found a significant difference in students' academic performance after the treatment,the experimental group was significantly higher than that of the control group. This shows that AI instructional platform had a positive impact on students' academic performance in Physics. This finding is in consonance with the submission of Okoye, et al. (2024), who reported that technology-enhanced learning significantly improved the academic performance of students in Physics in Nigerian secondary schools. Similarly, Eze and Iroegbu (2021) found that integrating digital instructional tools in science teaching enhanced students' understanding and problem-solving abilities. A plausible explanation for this improvement is that AI platforms provide interactive, personalized learning experiences and immediate feedback, which help students identify and address gaps in their understanding. Conventional teaching methods, by contrast, are often teacher-centered and may not address individual learning needs effectively, leading to lower performance outcomes. Moreover, studies by Adebayo and Bello (2023) have shown that students exposed to interactive and adaptive learning environments demonstrate higher retention and application of complex concepts compared to peers in traditional classrooms. However, Fwangle, et al. (2025), cautioned that the effectiveness of AI-based instruction can be moderated by factors such as teacher competence and resource availability, suggesting that successful implementation requires careful planning and support. This finding demonstrates the potential of AI instruction to enhance academic performance in Physics when properly integrated into teaching practices.

Recommendations

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

1. Schools and educational authorities should adopt AI instructional platforms like Khan Academy to enhance students' academic performance in Physics.
2. Physics teachers should receive training on the use of AI and digital learning platform like Khan Academy to maximize their effectiveness and ensure successful implementation in classrooms.
3. Government and school management should provide functional computer facilities and reliable internet access.

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IMPACT OF FEEDING PATTERN ON THE NUTRITIONAL STATUS OF UNDERGRADUATES IN FEDERAL UNIVERSITY OF TECHNOLOGY AKURE

BY

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ABSTRACT
This research centered on the impact of feeding pattern on the nutritional status of undergraduates in Akure South Local Government Area. Descriptive research design was used. The population of the study consisted of all undergraduates in Federal University of Technology, Akure. The sample size for this study was selected randomly by 204 students. The study employed both descriptive and inferential statistics Findings revealed that undergraduates do not slip meals, may repeat desired meals over and over again, may consume meals based on their taste and that undergraduates hardly eat three square meals value, Also, that undergraduates prefer readily made meals, have preference for junks, prefer meals that are affordable without minding the nutritional and that the absence of meals varieties for undergraduates, It was therefore recommended that undergraduates should acquire nutrition education which will help understand the need for balanced diets, there is need for undergraduates to be encouraged to prepare meals and shun fast meals, should pay attention to the state of health and avoid junks and that the over consumption of carbonated drinks should be avoided by undergraduates

Keywords: Feeding pattern, Nutritional Status, Undergraduates, Junk Foods

Introduction
Feeding pattern is the plan of meals models that indicates the kind of food eaten, when eaten as well as the ways they are obtained, stored, used, and discarded. Also, food patterns can be simply explained as the quantities, proportions, variety or combinations of different foods and beverages in diets, and the frequency with which they are habitually consumed. Feeding patterns are useful for determining single-nutrient analysis and a good way of understanding the possibilities in deficiencies of essential nutrients

Majority of undergraduates are adults or adolescents in which there are lots of transitions; physical, psychological, hormonal, cognitive and social transformation changes that occur during this growth period, the body's nutritional needs, eating habits and food choices fluctuate. These changes have implications towards the alarming rate of non-communicable disease including obesity, high glucose levels which are emerging public health problems globally especially in developing countries (James, 2019). A nutritional valuation is that evaluates the correct growth and development, somatic, psychological and social, avoiding deficiency states. The nutritional needs vary in function of the development stage and the genetic and metabolic differences in everyone (Khali. 2019). Good nutrition helps prevent diseases and develop physical and mental potential. Evaluation of nutritional status it's been used as an indicator of the health state and in the location of risk groups for deficiencies and excesses, which can be a risk factor in many of the most prevalent chronic diseases nowadays.

The food choice preferences of undergraduates and the kinds of foods popularly consumed may be mainly determined by the cost, availability, individual preference, nutrition education and most importantly the ability of undergraduates to prepare meals or their schedule. In a nutshell, undergraduates generally have preference for ready-made meals or fast foods which they easily purchase and cat without going through the stress of cooking. It is perceived that these poor eating habits may arise from lack of knowledge of the cumulative effects

of their eating habits. The last group of factors is probably the most important as the search for identity, the struggle for independence and acceptance, and concern about appearance, tends to have a great impact on lifestyle, eating patterns among adolescents (Raheena, 2019). Some illnesses are known to be lifestyle related like coronary diseases, obesity, high blood pressure, diabetes, and to a certain extent, osteoporosis.

Statement of the Problem

Poor nutritional pattern is a major public health concern among young adults who experience transition into university life during which they are exposed to stress and lack of time to prepare meals among other factors. Often, undergraduates tend to buy fast food from different food joints around the university while others eat from university cafeteria, and others can afford to cook in their hostels. Some undergraduates have reported skipping meals to achieve and maintain their desired body size. These routines can have an impact on the nutritional status of the undergraduates which may subsequently lead to decreased immunity, peptic ulcer disease, low weight, obesity, and cardiovascular diseases among others. Hence, the researcher investigates the impact of feeding patterns on the nutritional status of undergraduates at the Federal University of Technology Akure

Purpose of the Study

This study focused on feeding patterns and its impact on the nutritional status of undergraduates at Federal University of Technology Akure. Specifically, this research work:

i. examined the meal consumption pattern among undergraduates at Federal University of Technology, Akure
ii. assessed the food choice preference of undergraduates in at Federal University of Technology, Akure
iii. investigated the factors influencing the feeding patterns of undergraduates at Federal University of Technology, Akure
iv. determined the health implications of the consumption pattern of undergraduates at Federal University of Technology, Akure
v. suggested possible solution to the problem of unhealthy feeding pattern of undergraduates at Federal University of Technology, Akure

Research Questions

The following research questions were formulated to guide the study:

i. What are the meal consumption patterns among undergraduates at Federal University of Technology, Akure
ii. What are the food choice preferences of undergraduates at Federal University of Technology, Akure
iii. What are the factors influencing the feeding patterns of undergraduates at Federal University of Technology, Akure
iv. What are the health implications of the consumption pattern of undergraduates at Federal university of Technology, Akure
v. What are the solutions to the problem of unhealthy feeding pattern of undergraduates in Akure South Local Government Area?

Research Hypotheses

The following null hypotheses were formulated to guide the study, and tested at 0.05 level of significance:

H01: There is no significant influence of undergraduates' meal consumption patterns on their nutritional status at the Federal University of Technology, Akure

H02: There is no significant influence of undergraduates' food choice preferences on their nutritional status

Scope of the Study:

This study investigates the impact of feeding pattern on the nutritional status of undergraduates of The Federal University of Technology, Akure.

Methodology:

This study employed descriptive survey design. This research design elicited information by asking respondents questions on the impact of feeding patterns on the nutritional status of undergraduates at Federal University of Technology, Akure, Ondo State.

The population of the study consisted of all undergraduates in Federal University of

Technology, Akure. The total population of undergraduates in FUTA is eighteen thousand, five hundred and eighty-five (17,7516) (Source: FUTA, 2026).

The sample consisted of two hundred and four undergraduates (204) in FUTA constituted the respondents. Random sampling techniques was used to select undergraduates in the Federal University of Technology, Akure. A 4-Likert Scale structured questionnaire consisting of four (4) options denoting SA (4 points), A (3 points), D (2 points), SD (1 points) were used as the rating scale. The questionnaire was titled "impact of feeding pattern on the nutritional status of undergraduates in Akure South Local Government Area" which was used to collect information from the respondents. The research instrument contained two sections: Sections A and B. A thorough scrutiny of the research instrument was carried out by the researcher and two other experts in the Department of Home Economics, School of Vocational and Technical Education, Adeyemi College of Education, Ondo. Pilot study was conducted to establish the reliability of the research instrument. Therefore, test re-test methods of establishing reliability was applied by administering research instruments to twenty (20) undergraduates in Federal University of Technology Akure who were not part of the study. After a period of about two weeks, the same instrument was administered to same set of undergraduates. Data from both sets of responses were computed using Cronbach. The researcher personally administered and retrieved the questionnaires from the respondents. The completed copies of questionnaire were collected immediately to avoid loss in transit.

The responses to the questionnaire were collated and analyzed using Mean (X) and t-test

Results and Discussion

Research Question 1: What are the feeding patterns among undergraduates in FUTA

Table 1: Mean responses on the meal feeding patterns among undergraduates at Federal University of Technology, Akure

S/N	Items	$\bar{x}$	Decision
1	Undergraduates do not skip meals	3.22	Agreed
2	Undergraduates may repeat desired meals over and over again	3.65	Agreed
3	Undergraduates may consume meals based on their taste	3.25	Agreed
4	Undergraduates hardly eat three square meals value	3.71	Agreed

Table 1 shows mean responses on the meal feeding patterns among undergraduates in Akure South Local Government Area.. Items 1, 2, 3 and 4 have mean values of 3.22, 3.65, 3.25 and 3.71 respectively which are all above the cut-of point of 2.50 which implies that they undergraduates do not skip meals, may repeat desired meals over and over again, may consume meals based on tsssheir taste and that undergraduates hardly eat three square meals value.

Research Question 2: What are the food choices preferences of undergraduates in FUTA?

Table 2: Mean responses on the food choice preferences of undergraduates in Akure South Local Government Area

S/N	Items	$\bar{x}$	Decision
5	Undergraduates prefer readily made meals	3.26	Agreed
6	Undergraduates have preference for junks	3.58	Agreed
7	Undergraduates prefer meals that are affordable without minding the nutritional	3.43	Agreed
8	Absence of meals varieties for undergraduates	3.21	Agreed

Key: = mean, SD = Standard deviation
Source: Field Survey (2023)

Table 3 shows mean responses on the food choice preferences of undergraduates in Akure South Local Government Area. Items 1, 2, 3 and 4

have mean values of 3.26, 3.58, 3.43 and 3.21 respectively which are all above the cut-off point of 2.50 which implies that undergraduates prefer readily made meals, have preference for junks, prefer meals that are affordable without minding the nutritional and that the absence of meals varieties for undergraduates.

Research Question 3: What are the possible factors influencing the feeding patterns of undergraduates at FUTA

Table 3: Mean responses on the possible factors influencing the feeding patterns of undergraduates in FUTA

S/N	Items	$\bar{x}$	Decision
9	Undergraduates nutrition education influences their feeding pattern to consume balanced diets	3.65	Agreed
10	Undergraduates prepare meals by themselves and shun fast meals	2.33	Disagreed
11	Undergraduates pay attention to their state of health and avoid junks	2.21	Disagreed
12	The over consumption of carbonated drinks should be avoided by undergraduates	2.32	Disagreed

Key: = mean, SD = Standard deviation
Source: Field Survey (2023)

Table 3 shows the possible factors influencing the feeding patterns of undergraduates in Akure South Local Government Area. Items 1, 2, 3 and have 4 mean values of 3.65, 2.33, 2.21 and 2.32 which implies that the undergraduates should acquire nutrition education to help understand the need for balanced diets, they need to prepare meals and shun fast meals, they need to pay attention to the state of health, avoid junk foods and carbonated drinks

Research Question 4: What are the health implications of the feeding pattern of undergraduates in Akure South Local Government Area?

Table 4: Mean responses on the health implications of the feeding pattern of undergraduates in Akure South Local Government Area.

S/N	Items	$\bar{x}$	Decision
13	Undergraduates are prone to the risk of obesity	3.44	Agreed
14	Poor consumption pattern may lead to metabolic disorders	3.13	Agreed
15	Wrong consumption pattern may result into gastrointestinal ulcer	2.90	Agreed
16	Undergraduates may be at risk of overweight	3.42	Agreed

Key: = mean, SD = Standard deviation
Source: Field Survey (2023)

Table 4 presents the health implications of the feeding pattern of undergraduates in Akure South Local Government Area Items 1, 2, 3, 4 and 5 have mean values of 3.44, 3.13, 2.90 and 3.42 which are above the cut-off point of 2.50 which implies that the respondents agreed that undergraduates are prone to the risk of obesity, poor consumption pattern may lead to metabolic disorders, wrong consumption pattern may result into gastrointestinal ulcer and that undergraduates may be at the risk of overweight.

Research Question 5: What are the possible solutions to the problem of bad feeding pattern of undergraduate in Akure South Local Government Area?

Table 5: Mean responses on the possible solutions to the problem of unhealthy feeding pattern among undergraduates in Akure South Local Government Area

S/N	Items	$\bar{x}$	Decision
17	Individual preference of undergraduates determines their feeding pattern	3.22	Agreed
18	The gender of undergraduates may determine their feeding pattern	3.25	Agreed
19	The cost of meals affects feeding patterns	3.65	Agreed
20	The availability of meals dictates feeding patterns	3.13	Agreed

Key: = mean, SD = Standard deviation
Source: Field Survey (2023)

Table 5 presents the possible solutions to the problem of bad feeding patterns of undergraduates in Akure South Local Government Area. Items 1, 2, 3, 4 and 5 have mean values of 3.22, 3.25, 3.65 and 3.13 which are above the cut-off point of 2.50 which implies that the respondents agreed that individual preference of undergraduates determines their feeding pattern the gender of undergraduates may determine their feeding pattern, the cost of meals affects feeding patterns and that availability of meals indicates feeding patterns.

Test of Hypotheses

$H0_1$: There is no significant influence of undergraduates' meal consumption pattern on their nutritional status.

ITEM	$\bar{X}$	DF	T – cal	T – tab	Decision
X_1	89				
X_2	115	205	4.21	2.31	Rejected

Table 6 shows the relationship between the meal consumption patterns of undergraduates and their nutritional status. At 0.05 alpha level, the T-tabulated is 2.31 and the T-calculated value is 4.21 which is greater than t-tab. Hence, hypothesis 1 was rejected which implies there is no significant relationship between the meal consumption patterns of undergraduates and their nutritional status (df=202; T-cal-4.21>T-tab = 2.31).

$H0_2$: There is no significant relationship between the food choice preferences of undergraduates and patterns of undergraduates and their nutritional status

ITEM	$\bar{X}$	DF	T – cal	T – tab	Decision
X_1	72				
X_2	132	202	5.56	2.31	Rejected

Table 6 shows the relationship between the food choice preferences of undergraduates and patterns of undergraduates and their nutritional status. At 0.05 alpha level, the T-tabulated is 2.31 and the T-calculated value is 5.56 which is greater than t-tab. Hence, hypothesis 2 was rejected which implies there is significant relationship between the food choice preferences of undergraduates and patterns of undergraduates and their nutritional status (df = 202; T-cal-5.56>T-tab =2.31).

Discussion of Findings

Table 1 presented the responses on the feeding patterns among undergraduates in Akure South Local Government Area. Respondents agreed that undergraduates do not skip meals, may repeat desired meals over and over again, may consume meals based on their taste and that undergraduates hardly eat three square

meals. Musaiger (2017) stated that the food habit of undergraduates is uncertain as some avoid certain foods because of personal dislike, social and cultural pressure, peer group influence, religion among others, not knowing what those food items could contribute to the adequacy and inadequacy of their nutrient intake. In view of this, Raheena, (2019) noted that nutritional problems of adolescents, whether under nutrition or related to chronic diseases, are mainly the result of dietary inadequacies. These may be linked to a number of physiological, socio-economic and psychosocial factors. The last group of factors is probably the most important as the search for identity, the struggle for independence and acceptance, and concern about appearance, tends to have a great impact on lifestyle, eating patterns among adolescents.

Tables 2 presented responses on the food choice preferences of undergraduates in Akure South Local Government Area. Respondents agreed that undergraduates prefer readily made meals, have preference for junks, prefer meals that are affordable without minding the nutritional and that the absence of meals varieties for undergraduates. Musaiger (2017) noted that the poor feeding habits, such as skipping of meal especially breakfast, low intake of fruits and vegetables, milk, fish and high intake of fast food, sweets, and sugar-sweetened beverages are present in the diets of University students. In support of this, Fawemi (2019) noted that patterns of nutritional behavior adopted by undergraduates are mostly continued in adults' life and increased the risk of development of many chronic diseases.

Table 3 presented responses on the possible factors influencing the feeding patterns of undergraduates in Akure South Local Government Area. Respondents agree that undergraduates should acquire nutrition education which will help understand the need for balanced diets, should be encouraged to prepare meals and shun fast meals, should pay attention to the state of health and avoid junks, the over consumption of carbonated drinks should be avoided by undergraduates and that poor lesson delivery and inadequate classroom management. Sogari, (2018) reiterated that due to a variety of reasons, including a new environment, lack of time, lack of access to variety, snacking, stress, kipping meals, convenience, frugality, emotional eating, and dieting. In addition, Ajala (2018) noted that poor eating habits may likely arise from lack of knowledge of the cumulative effects of their eating habits. In Nigeria, where there is an increase in fast food centers in its urban cities, it is a major concern. Undergraduates preparing their food have less problems of food poison as most of the catering establishment do not abide by the rules guiding hygienic practices (Bello *et al* 2022)

Table 4 presented responses on the health implications of the feeding pattern of undergraduates in Akure South Local Government Area. Respondents agreed that undergraduates are prone to the risk of obesity, poor consumption pattern may lead to metabolic disorders, wrong consumption pattern may result into gastrointestinal ulcer and that undergraduates may be at the risk of overweight. In support of this, Adams (2019) noted that poor feeding pattern will affect the overall academic performance of undergraduates in as much as there will be series of health problems which will not only reduce the academic time but also reduce their level of concentration. In addition Khali (2019) noted that a good nutrition helps prevent diseases and to develop physical and mental potential. Evaluation of the nutritional status is used as an indicator of the health state and in the location of risk groups for deficiencies and excesses, which can be a risk factor in many of the most prevalent chronic diseases nowadays.

Table 5 showed responses on the possible solutions to the problem of unhealthy feeding pattern of undergraduates in Akure South Local Government Area. Respondents agreed that individual preference of undergraduates determines their feeding pattern, the gender of undergraduates may determine their feeding pattern. In view of this Al-Nakeeb (2015) have suggested the need for good nutritional knowledge since poor eating habits may likely arise from lack of knowledge of the cumulative effects of their eating habits. In addition, Nutrition education programs can be organized for undergraduates where they will learn simple methods of preparing nutritive and hygienic meals, this is in line with Adeyanju *et al* (2025) who stated that proper food preparation improves the hygiene and

quality of food. Meg (2012) noted that food centers in its urban cities is a major concern due to high cost and hygiene maintenance. Most undergraduates are likely to be responsible for their diets for the first time away from home, therefore they need guidance on how to make informed dietary choices (Other studies have linked the lifestyle of students, especially breakfast consumption, to their mental abilities which is reflected in their academic performance. Bolade *et al* (2016) described easy method for preparing local and highly nutritive snacks which undergraduates can adopt.

Conclusion and recommendations

This study revealed that undergraduates are aware of importance of cooking, but they rely on junk foods, carbonated foods and eating in restaurants leading to diseases among them. This is due to time constraints and laziness on the part of undergraduates. This work therefore recommends organizing nutrition education on regular basis to keep them informed and learn easy methods of food preparation.

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AWARENESS, ACCESSIBILITY, AND PERCEPTION OF ONLINE TEACHING PLATFORMS AMONG UNIVERSITY LECTURERS IN SOUTHWEST NIGERIA

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Abstract

This study examined awareness, accessibility, and perception of online teaching platforms among university lecturers in Southwest Nigeria, with emphasis on how these factors influence integration of digital technologies in higher education. A descriptive survey research design was adopted. Data were collected from 312 lecturers selected through multistage sampling procedure from selected public universities in the region. A structured questionnaire, validated by experts, was used for data collection and yielded reliability coefficient of 0.87. Data were analysed using descriptive statistics and Pearon's Product Moment Correlation. Findings revealed high awareness of online teaching platforms among lecturers (Mean = 3.42, SD = 0.68), indicating widespread familiarity with digital instructional tools. Accessibility was moderate (Mean = 2.91, SD = 0.74), suggesting infrastructural and institutional constraints. Perception of online teaching platforms was moderately positive (Mean = 3.08, SD = 0.71), reflecting recognition of their academic value. The study established significant positive relationships between awareness and perception (r = 0.62, p < 0.05), and between accessibility and perception (r = 0.55, p < 0.05). It was concluded that limited accessibility constrains utilisation and shapes perception, despite high awareness. Based on the findings, it was recommended that universities should *improve digital infrastructure and staff training programmes.*

Keywords: University lecturers, awareness; accessibility, perception, digital learning

Introduction

The landscape of higher education has undergone significant transformation in recent decades, driven largely by rapid advancements in digital technology. Traditional modes of instruction, which were once confined to physical classrooms, are increasingly being complemented or replaced by technology-mediated approaches that extend learning beyond geographical and temporal boundaries. In this evolving academic environment, the integration of online teaching platforms has become a central component of contemporary pedagogical practice, enabling institutions to enhance instructional delivery, improve access to knowledge, and remain competitive in a globalised education system.

The growing adoption of online teaching platforms is closely linked to broader global trends such as digitalisation, global connectivity, and the increasing demand for flexible learning opportunities. These platforms include learning management systems, virtual classrooms, and collaborative digital tools have redefined the processes of teaching and learning by facilitating interactive content delivery, real-time communication, and continuous assessment of learners. As

noted by Dhawan (2020) and Adedoyin and Soykan (2020), online teaching platforms not only enhance instructional efficiency but also support diverse learning styles through synchronous and asynchronous engagement.

Integration of online teaching platforms into higher education systems in the developed nations has been largely successful and supported by robust digital infrastructure, institutional policies, and continuous capacity-building initiatives. Universities across North America, Europe, and parts of Asia have leveraged these technologies to improve teaching effectiveness, increase student participation, and expand access to education (Means, Toyama, Murphy, & Baki, 2014). However, the situation in developing countries, including Nigeria, presents a more complex reality, where infrastructural deficits and systemic challenges continue to limit the full realisation of these benefits.

The adoption of online teaching platforms in Nigeria has evolved gradually but gained significant momentum during the COVID-19 pandemic. The disruption of conventional face-to-face instruction necessitated an abrupt transition to remote teaching, thereby accelerating the use of digital platforms across universities. Although this digital era created opportunities for innovation, yet it exposed critical gaps in technological preparedness, digital competence, and institutional support systems among academic staff (Aristovnik et al., 2020; Almaiah, Al-Khasawneh, & Althunibat, 2020).

Concentration of prominent universities in Southwest Nigeria has made it to be widely recognised as an academic hub, providing relevant context for examining the adoption of online teaching platforms compared to other regions. Athough institutions in this region have made efforts to integrate digital technologies into teaching, disparities remain in terms of lecturers' level of awareness, access to technological resources, and attitudes toward these platforms (Aina et al., 2022) These disparities raise important questions regarding the effectiveness, sustainability, and equity of online teaching practices within the region.

One of the perceived factors influencing the adoption of online teaching platforms is the level of awareness among lecturers. Awareness extends beyond mere recognition of digital tools to include a comprehensive understanding of their functionalities, applications, and potential benefits in instructional delivery. Lecturers who possess a high level of awareness are more likely to experiment with and effectively utilise online teaching platforms, thereby enhancing teaching outcomes. Conversely, limited awareness may result in underutilisation or ineffective use of available technologies (Afolabi et al., 2021).

Accessibility to online teaching platforms could also determines the extent to which lecturers can practically engage with online teaching platforms. Accessibility encompasses factors such as availability of digital devices, internet connectivity, technical support, and institutional infrastructure. In many Nigerian universities, accessibility remains constrained by challenges such as unstable electricity supply, high cost of internet data, and inadequate technological facilities. These limitations significantly hinder lecturers' ability to integrate online teaching platforms into their instructional practices (Okoye et al., 2021).

Lecturers' perception of online teaching platforms plays a crucial role in shaping their adoption behaviour. Perception reflects lecturers' attitudes, beliefs, and experiences regarding the usefulness, ease of use, and effectiveness of these platforms. Drawing from the Technology Acceptance Model (TAM), perceived usefulness and perceived ease of use are key determinants of technology adoption (Teo, 2011). Lecturers who perceive online teaching platforms as beneficial and user-friendly are more likely to adopt and sustain their use, whereas negative perceptions may lead to resistance or minimal engagement.

Importantly, awareness, accessibility, and perception are not isolated constructs but are interrelated factors that collectively influence the adoption and utilisation of online teaching platforms. Increased awareness can enhance perception by improving understanding of technological capabilities, while accessibility conditions can shape user experience and attitudes toward these platforms.

Furthermore, variations in institutional capacity, policy implementation, and technological readiness across universities contribute to differences in lecturers' experiences with online teaching platforms. Demographic factors such as age, teaching experience, academic rank, and digital literacy also play a role in shaping lecturers' engagement with these technologies. These variations underscore the need for a holistic investigation that captures both individual and contextual influences on the adoption of online teaching platforms.

Despite increasing interest in digital learning, the integration of online teaching platforms in Nigerian universities remains uneven. While some lecturers demonstrate proficiency and enthusiasm in using these tools, others exhibit limited engagement or resistance. This inconsistency suggests the need for empirical

investigation into lecturers' awareness, accessibility and perception of their online teaching platform

In view of these concerns, this study examines the level of awareness, accessibility, and perception of online teaching platforms among university lecturers in Southwest Nigeria. It also explores the relationships among these variables in order to provide empirical insights that can inform policy decisions, institutional strategies, and capacity-building initiatives aimed at enhancing digital teaching practices in higher education.

Statement of the Problem

The increasing integration of online teaching platforms into higher education has fundamentally reshaped instructional delivery across the globe. In Nigeria, universities have made considerable efforts to adopt these platforms in response to evolving pedagogical demands and external pressures such as the COVID-19 pandemic. Despite these efforts, the level of utilisation of online teaching platforms among university lecturers remains uneven and, in many cases, suboptimal. While some lecturers demonstrate active engagement and proficiency in the use of digital teaching tools, others exhibit limited usage or complete reluctance. This inconsistency raises critical concerns regarding the underlying factors influencing lecturers' engagement with online teaching platforms.

One major issue relates to the level of awareness among lecturers. Although various online teaching platforms have been introduced within universities, it is uncertain whether lecturers possess sufficient and functional knowledge of their features, instructional relevance, and application in teaching. Mere exposure to digital tools does not necessarily translate into effective utilisation, and inadequate awareness may contribute to superficial or inefficient use of available platforms.

Researchers observed that the presence of online teaching platforms within institutions seem not to guarantee lecturers effective usage, which could be as a result of encountering barriers such as unreliable internet connectivity, unstable electricity supply, limited access to digital devices, and insufficient technical support. These infrastructural and institutional constraints can significantly hinder lecturers' ability to integrate online teaching platforms into their instructional practices, thereby limiting the potential benefits of digital learning.

Furthermore, lecturers' perception of online teaching platforms constitutes a critical determinant of their adoption and sustained use. While some lecturers may perceive these platforms as innovative and beneficial, others may view them as complex, time-consuming, or incompatible with their teaching styles. Such divergent perceptions can influence lecturers' willingness to engage with online teaching technologies and may partly explain the observed variation in utilisation.

Despite the importance of awareness, accessibility, and perception, existing studies have largely examined these variables in isolation, with limited attention to their combined and interactive effects. Moreover, there is a paucity of context-specific empirical evidence focusing on university lecturers in Southwest Nigeria, where institutional diversity and infrastructural disparities may uniquely shape digital teaching practices.

Consequently, there is a need to systematically investigate the level of awareness of online teaching platforms among university lecturers, the extent to which these platforms are accessible, and how lecturers perceive their use. It is also essential to examine whether significant relationships exist between awareness and perception, as well as between accessibility and perception. Addressing these issues will provide a more comprehensive understanding of the factors influencing lecturers' engagement with online teaching platforms and inform strategies for improving digital teaching practices in Nigerian universities.

Objectives of the Study

The main objective of this study is to examine the awareness, accessibility, and perception of online teaching platforms among university lecturers in Southwest Nigeria.

The specific objectives are to:

1. determine the level of awareness of online teaching platforms among university lecturers in Southwest Nigeria;
2. assess the extent of accessibility to online teaching platforms among university lecturers in Southwest Nigeria;
3. examine the perceptions of university lecturers toward the use of online teaching platforms;
4. investigate the relationship between awareness of online teaching platforms and lecturers' perception of their use;
5. examine the relationship between accessibility of online teaching platforms and lecturers' perception of their use.

Research Questions

The following research questions guided the study:

1. What is the level of awareness of online teaching platforms among

university lecturers in Southwest Nigeria?
2. To what extent are online teaching platforms accessible to university lecturers in Southwest Nigeria?
3. What are the perceptions of university lecturers toward the use of online teaching platforms in Southwest Nigeria?
4.

Research Hypotheses

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

1. **H_{01}:** There is no significant relationship between awareness of online teaching platforms and lecturers' perception of their use in Southwest Nigeria.
2. **H_{02}:** There is no significant relationship between accessibility of online teaching platforms and lecturers' perception of their use in Southwest Nigeria.
3.

Methodology

This study adopted a descriptive research design of the survey type. This design was considered appropriate because it allows for the systematic collection of data from a representative sample in order to describe the characteristics of a population and examine relationships among variables without manipulating them.

The population of the study comprised all university lecturers in selected public universities in Southwest Nigeria. A total of 312 lecturers constituted the sample size for the study. Given the large size of the population, a multistage sampling procedure was employed. In the first stage, three states were selected using simple random sampling. In the second stage, one public university was selected from each state using purposive sampling based on institutional size and availability of online teaching platforms. In the final stage, lecturers were selected using random sampling based on faculties to ensure adequate representation across disciplines.

Data were collected using a structured questionnaire titled "Awareness, Accessibility and Perception of Online Teaching Platforms Questionnaire (AAPOTPQ)". The instrument consisted of four sections: Section A captured demographic information, while Sections B, C, and D measured awareness, accessibility, and perception respectively using a 4-point Likert scale ranging from *Strongly Agree (4)* to *Strongly Disagree (1)*.

The instrument was subjected to face and content validity by experts in educational technology and measurement and evaluation. Their suggestions were incorporated to improve clarity and relevance of the items. The reliability of the instrument was determined using Cronbach's alpha, which yielded a coefficient of 0.87, indicating that the instrument was highly reliable.

Data collected were analysed using both descriptive and inferential statistics. Descriptive statistics such as mean and standard deviation were used to answer the research questions, while inferential statistics, specifically Pearson Product Moment Correlation (PPMC), were used to test the hypotheses at 0.05 level of significance.

Data Analysis and Presentation

Decision Rule

A benchmark mean of **2.50** was used.

- Mean ≥ 2.50 = Agreed / High / Accessible / Positive
- Mean < 2.50 = Disagreed / Low / Not accessible / Negative

Research Question 1

What is the level of awareness of online teaching platforms among university lecturers in Southwest Nigeria?

Table 1: Mean and standard deviation on the **level of awareness of online teaching platforms among university lecturers**

S/N	Awareness Items	Mean	SD	Decision
1	I am aware of Zoom as an online teaching platform	3.61	0.62	High
2	I am aware of Google Classroom	3.45	0.70	High
3	I am aware of Microsoft Teams for teaching	3.38	0.74	High
4	I am aware of Moodle LMS	3.22	0.81	High
5	I am aware of Canvas LMS	3.10	0.83	High
6	I know how online teaching platforms function	3.05	0.79	High
7	I am aware that my institution provides online platforms	3.28	0.76	High
8	I am aware of recorded lecture tools	3.41	0.69	High
9	I am aware of assessment tools on online platforms	3.33	0.72	High
10	I am aware of multiple platforms for virtual teaching	3.27	0.75	High

Cluster Mean = 3.31

Interpretation

The cluster mean of 3.31 indicates a high level of awareness of online teaching platforms among university lecturers in Southwest Nigeria. The analysis of awareness of online teaching platforms among university lecturers in Southwest Nigeria revealed a generally high level of awareness across all measured items. Specifically, lecturers recorded high mean scores across all ten items, ranging from 3.05 to 3.61, with an overall cluster mean of 3.31 (SD = 0.74).

The highest-rated item was awareness of Zoom as an online teaching platform with a mean score of 3.61 (SD = 0.62), indicating that almost all lecturers are familiar with synchronous video conferencing tools. This was closely followed by awareness of Google Classroom (M = 3.45) and Microsoft Teams (M = 3.38), suggesting that widely circulated global platforms dominate lecturers' awareness profiles.

Even relatively technical components such as Learning Management Systems recorded strong awareness levels, with Moodle (M = 3.22) and Canvas (M = 3.10) both exceeding the decision benchmark of 2.50. The consistency of high ratings across all items suggests that awareness is not isolated to a few tools but is broadly distributed across multiple categories of online teaching platforms.

The cluster mean of 3.31 further confirms that lecturers in Southwest Nigeria possess a high and functionally relevant level of awareness, meaning that lack of knowledge is unlikely to be a major barrier to adoption in this context.

RESEARCH QUESTION 2

To what extent are online teaching platforms accessible to lecturers?

Table 2: Mean and standard deviation on the **extent of online teaching platforms accessible by lecturers**

S/N	Accessibility Items	Mean	SD	Decision
1	I have stable internet access for teaching	2.41	0.88	Low
2	I have access to a functional laptop/PC	2.96	0.77	Moderate
3	My institution provides adequate ICT support	2.58	0.81	Moderate
4	I have access to Zoom/Teams without difficulty	2.73	0.79	Moderate
5	Electricity supply supports online teaching	2.10	0.91	Low
6	I can easily upload teaching materials online	3.05	0.74	High
7	Internet data is affordable for me	2.32	0.84	Low
8	I have access to institutional e-learning platforms	2.89	0.80	Moderate
9	Technical support is readily available	2.54	0.83	Moderate
10	I can teach online without interruption	2.37	0.86	Low

Cluster Mean = 2.60

Interpretation

The cluster mean of 2.60 shows that accessibility to online teaching platforms is moderate, though several infrastructural barriers still exist. Findings on accessibility of online teaching platforms indicate a moderate overall level of accessibility, with a cluster mean of 2.60 (SD = 0.82). However, this moderate average masks a significant internal variation across items, ranging from 2.10 to 3.05.

The highest accessibility score was recorded for ease of uploading teaching materials online (M = 3.05) and access to personal devices such as laptops or computers (M = 2.96), indicating that lecturers generally have basic digital tools required for online engagement.

However, critical infrastructural challenges were evident in several low-scoring items. Electricity supply recorded a mean of 2.10, the lowest in the construct, clearly indicating that unstable power supply remains a major constraint. Similarly, affordability of internet data (M = 2.32) and uninterrupted online teaching experiences (M = 2.37) also fell below the acceptable threshold, reflecting systemic infrastructural weaknesses.

Although institutional ICT support (M = 2.58) and access to LMS platforms (M = 2.89) fall within the moderate range, they are not strong enough to compensate for broader environmental limitations. This imbalance suggests that accessibility is unevenly distributed, with lecturers relying more on personal resources than institutional support systems.

Overall, the cluster mean of 2.60 indicates that while access exists, it is fragile, inconsistent, and highly dependent on external conditions such as power and internet stability.

Research Question 3
What is the perception of lecturers toward online teaching platforms?

Table 3: Mean and standard deviation on **perception of lecturers toward online teaching platforms**

S/N	Perception Items	Mean	SD	Decision
1	Online platforms improve teaching effectiveness	3.42	0.70	Positive
2	They make teaching more flexible	3.38	0.72	Positive
3	They are easy to use	2.61	0.85	Moderate
4	They reduce workload	2.44	0.90	Negative
5	They improve student engagement	3.20	0.76	Positive
6	They are time-consuming	2.40	0.88	Negative
7	I enjoy using online teaching platforms	3.05	0.79	Positive
8	They are suitable for my teaching style	2.98	0.80	Moderate
9	I prefer online teaching over face-to-face	2.36	0.91	Negative
10	They are useful for modern education	3.44	0.69	Positive

Cluster Mean = 2.93

Interpretation

The cluster mean of 2.93 indicates a generally moderately positive perception of online teaching platforms among lecturers. The perception of lecturers toward online teaching platforms shows a moderately positive disposition, with a cluster mean of 2.93 (SD = 0.79). However, the item-level analysis reveals a mixed perception pattern rather than a uniformly positive attitude.

Lecturers strongly agreed that online teaching platforms improve teaching effectiveness (M = 3.42) and enhance flexibility (M = 3.38). They also acknowledged their usefulness for modern education (M = 3.44) and their capacity to improve student engagement (M = 3.20). These high scores indicate that lecturers intellectually recognize the pedagogical value of online teaching platforms.

However, contrasting perceptions emerged in areas related to workload and usability. For instance, lecturers rated the statement that online platforms reduce workload at a low mean of 2.44, indicating disagreement. Similarly, the perception that online teaching is time-consuming recorded a mean of 2.40, showing that lecturers associate these platforms with increased effort rather than efficiency.

Preference-related items also revealed hesitation. The statement "I prefer online teaching over face-to-face instruction" recorded a low mean of **2.36**, suggesting that traditional teaching methods are still preferred despite awareness of digital benefits. Taken together, these results indicate a **dual perception structure**: lecturers acknowledge the academic value of online platforms but simultaneously express concerns about usability, workload, and instructional convenience.

Research hypothesis 1

There is no significant relationship between awareness of online teaching platforms and lecturers' perception of their use in Southwest Nigeria.

Table 4: Correlation between Awareness and Perception

Variables	N	R	p-value	Decision
Awareness & Perception	312	0.62	0.000	Significant

Interpretation:

A significant positive relationship exists between awareness and perception. Higher awareness leads to more positive perception. The relationship between awareness and perception of online teaching platforms among lecturers yielded a Pearson's correlation coefficient of r = 0.62 (p = 0.000). This indicates a strong, positive, and statistically significant relationship at the 0.05 level.

This means that as lecturers' awareness of online teaching platforms increases, their perception of these platforms becomes more positive. The strength of the correlation (0.62) suggests a substantial association, implying that awareness is a major cognitive factor shaping how lecturers evaluate the usefulness and relevance of online teaching tools. The significance level (p = 0.000) confirms that this relationship is not due to

chance but reflects a consistent pattern within the population studied.

Research hypothesis 2

There is no significant relationship between awareness of online teaching platforms and lecturers' perception of their use in Southwest Nigeria

Table 5: Correlation between Accessibility and Perception

Variables	N	R	p-value	Decision
Accessibility & Perception	312	0.55	0.000	Significant

Interpretation:

A significant positive relationship exists between accessibility and perception. The relationship between accessibility and perception of online teaching platforms also revealed a moderate to strong positive relationship, with a correlation coefficient of r = 0.55 (p = 0.000).

This finding suggests that lecturers who have better access to online teaching infrastructure tend to develop more positive perceptions of these platforms. Accessibility appears to influence perception through experience. Lecturers who can consistently use online platforms under stable conditions are more likely to view them as effective and beneficial. However, the strength of 0.55 indicates that while accessibility is important, it is not the sole determinant of perception. Other factors such as training, digital literacy, and institutional support may also play significant roles. The statistical significance (p = 0.000) confirms a reliable relationship between both variables across the sampled lecturers.

Discussion of Findings

The study revealed a high level of awareness (M = 3.31) among university lecturers regarding online teaching platforms. This finding indicates that lecturers are generally familiar with a wide range of digital teaching tools, including video conferencing platforms and learning management systems. The implication is that awareness is no longer a primary barrier to the adoption of online teaching platforms within the study context.

This finding aligns with Adedoyin and Soykan (2020), who observed that the COVID-19 pandemic significantly increased lecturers' exposure to digital teaching tools, thereby enhancing awareness levels across higher education institutions. Similarly, Almaiah et al., (2020) reported that increased awareness contributes to greater readiness for technology adoption among educators. However, the finding contrasts with earlier studies such as Afolabi et al. (2021), which reported limited awareness of advanced learning platforms among lecturers in some Nigerian institutions. The discrepancy may be attributed to recent developments in digital education, including increased institutional emphasis on online teaching and expanded training opportunities following the pandemic. The implication of this finding is that interventions aimed at improving digital teaching should shift focus from basic awareness to deeper engagement, skill development, and effective utilisation of online teaching platforms.

The study found that accessibility to online teaching platforms is moderate (M = 2.60), indicating that while lecturers have some level of access, it is constrained by infrastructural limitations. This finding highlights the persistent challenges associated with digital teaching in developing contexts. The result is consistent with Okoye et al. (2021), who identified infrastructural deficits such as poor electricity supply, high internet costs, and inadequate ICT support as major barriers to e-learning adoption in Nigerian universities. Similarly, Adedoyin and Soykan (2020) emphasised that accessibility challenges significantly hindered the effectiveness of online teaching during the pandemic.

In contrast, studies conducted in developed countries (Means et al., 2014) report minimal accessibility constraints due to well-established digital infrastructure and institutional support systems. This contrast underscores the structural disparities between developed and developing educational systems. The implication of this finding is that improving accessibility requires systemic interventions, including investment in infrastructure, institutional support, and policy implementation. Without addressing these structural challenges, the benefits of online teaching platforms may remain underutilised.

The findings indicated a moderately positive perception (M = 2.93) among lecturers toward online teaching platforms. This suggests that while lecturers recognise the benefits of digital teaching tools, they also experience challenges that influence their attitudes. This result is consistent with Dhawan (2020), who reported that educators generally acknowledge the flexibility and effectiveness of online learning but express concerns about increased workload and technical challenges. Similarly, Teo (2011) emphasised that perceived usefulness and ease of use are critical determinants of technology acceptance.

In the Nigerian context, Aina et al. (2022) also found that lecturers' perceptions of online teaching platforms are influenced by

both perceived benefits and practical challenges such as limited technical skills and inadequate support systems. The implication is that lecturers' perceptions are shaped by both cognitive evaluation and practical experience. While they appreciate the theoretical benefits of online teaching platforms, operational challenges reduce their enthusiasm for full adoption.

The study established a strong positive relationship between awareness and perception (r = 0.62), indicating that increased awareness enhances lecturers' perception of online teaching platforms. This finding supports Almaiah et al. (2020) and Ifinedo (2020), who reported that awareness significantly influences users' attitudes toward technology by improving understanding of its benefits. The result can be explained through cognitive learning principles, which suggest that knowledge and understanding shape attitudes and behavioural intentions. The implication is that enhancing lecturers' awareness through training and exposure can indirectly improve their perception and increase the likelihood of adoption and sustained use of online teaching platforms.

The study also revealed a significant positive relationship between accessibility and perception (r = 0.55), indicating that better access to digital infrastructure contributes to more positive attitudes among lecturers. This finding aligns with Adedoyin and Soykan (2020), who noted that improved access leads to better user experiences and more favourable perceptions. Similarly, Okoye et al. (2021) emphasised that infrastructural support plays a critical role in shaping lecturers' attitudes toward e-learning technologies.

However, the moderate strength of the relationship suggests that accessibility alone is not sufficient to guarantee positive perception, thereby supporting Teo's (2011) argument that other factors, such as ease of use and perceived usefulness, also play important roles.

Conclusion

This study examined the awareness, accessibility, and perception of online teaching platforms among university lecturers in Southwest Nigeria. The findings revealed that lecturers possess a high level of awareness of online teaching platforms, indicating widespread familiarity with digital teaching tools. However, accessibility was found to be moderate, reflecting persistent infrastructural challenges that constrain effective utilisation.

The study further established that lecturers' perception of online teaching platforms is moderately positive, suggesting that while lecturers recognise their pedagogical value, practical challenges such as workload and usability concerns influence their attitudes. In addition, significant positive relationships were found between awareness and perception, as well as between accessibility and perception, highlighting the interconnected nature of these variables.

Overall, the study concludes that although the foundation for digital teaching is well established in terms of awareness, the effective integration of online teaching platforms in Southwest Nigeria remains constrained by infrastructural and experiential limitations.

Recommendations

1. Universities should allow for deeper engagement, skill development, and effective utilisation of online teaching platforms among Lecturers since they are more aware of online teaching platforms.
2. Government and institutional authorities should invest in reliable ICT infrastructure, particularly stable internet connectivity and electricity supply, to improve accessibility.
3. Universities should provide subsidised internet access or institutional data support to reduce the financial burden on lecturers thereby increasing their access to online teching platforms.
4. Technical support systems should be strengthened to provide timely assistance during online teaching activities and by so doing, lecturers perception of online teaching platforms will improve.
5. Institutions should adopt blended learning approaches that integrate online and face-to-face teaching to improve acceptance and ease the transition to digital instruction.

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EFFECTS OF BLENDED LEARNING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN BIOLOGY IN EKITI STATE

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Abstract
This study examined the effects of blended learning on senior secondary school students' learning outcomes in Biology in Ekiti State. Specifically, it investigated whether blended learning could improve students' academic performance and attitude towards Biology compared with the conventional teaching method. Quasi-experimental of pre-test, post-test control group design was adopted for the study. The population consisted of 5,177 Senior Secondary School Biology students in Ekiti State, from which a sample of 120 Senior Secondary School Two students were selected using a multistage sampling procedure across six schools in the three senatorial districts. Participants were divided into experimental and control groups. The experimental group was taught using blended learning strategy, while the control group received instruction through the conventional teaching method. Data were collected using two instruments: the Biology Performance Test (BPT) and the Students' Attitudinal Questionnaire in Biology (SAQB). The instruments were validated by experts, and reliability coefficients of 0.76 and 0.82 were obtained respectively using the test re-test method. Data were analyzed using descriptive statistics and inferential statistics, with hypotheses tested at the 0.05 level of significance. The findings revealed that students exposed to blended learning performed significantly better than those taught using the conventional method. However, gender had no significant effect on students' attitudes toward Biology when exposed to blended learning. The study recommended the integration of blended learning strategies in Biology teaching to promote interactive and individualized learning among secondary school students in Ekiti State.

Keywords: *Blended learning, learning outcomes, conventional instruction method.*

Introduction

Education is a well- known essential tool to empower individual and develop a nation, it may be used in intellectual, cultural, and social development of the society. Education contributes to production of needed personnel for operation at different sectors of the national economy and development processes. It is also a bed rock for human development. According to Uwazurike and Anokam in Obialor (2022), education is any act or experience that has a formative effect on the minds, character or physical ability of an individual. It is the act or process of impacting or acquiring knowledge, skills, values, belief and habit. In Nigeria, the educational system is categorized into pre-primary schools, primary schools, secondary school and tertiary education. Secondary education plays a vital role in shaping the life of individual because it serves as a link between primary school and tertiary education. Without secondary school education, the foundation for any form of future academic aspirations cannot be laid (Abdulrahaman, 2020).

The contributions of science and technology to overall development of all nations cannot be underestimated. Technology is the application of science to solve problems. Any learning that use technology or makes use of practices that

use technology is termed digital learning (blended and virtual learning).Technology has been identified as playing a critical role in the scientific advancement in the 21st century. Science encompasses the realm of human pursuit focused on providing accurate explanations for the phenomena and condition inherent in our natural surroundings, it establishes governing principles that regulate the natural world, subsequently instigating systematic and predictable event within it, as emphasized by Remi and Akujobi (2019). And for this reason, science is considered to have occupied an important position in the curriculum of Nigerian educational system. The scientific revolution that is occurring right now is being molded by developments in both science and technology.

One of the primary objectives of science education is to develop the student into a person who is capable of competing successfully on a global scale. Iroriteraye--Adjekpovu and Osimala (2020), stated that the type of teaching that is required for global learning in the 21st century is that which encourage students active participation where they learn at their own Pace, space and interact with both human and material resources to discover facts for themselves leading to meaningful learning.

Biology is one of the science subjects that is taught in secondary schools in Ekiti State, Nigeria according to the country's curriculum. It is one of the science subjects that senior secondary students offer in senior secondary certificate examinations in Nigeria (FRN, 2015). Biology is the study of living things and their vital processes. The goals of studying Biology include; providing the learner with the knowledge, skills, and mindset that are essential for enabling them to protect and conserve the environment, regulate population, fight illnesses, and increase food supply. Therefore, having a solid understanding of Biology improves grades and is a necessary precondition for a variety of exciting and varied jobs and pre-requisite to the study of courses in the fields of medical, nursing, food science, pharmacy, and other related fields (Olayinka & Ogundare, 2023).As important as Biology is, it becomes difficult to learn if not approach with the right instructional strategy.

Despite the prime position Biology occupies in our educational system, and the efforts made by researchers to enhance performance, students' performance in the science subjects in general, and Biology in particular still fluctuating. Some of the reasons observed for the fluctuations are; ineffective instructional method, insufficient Biology teachers, inadequate laboratory, in conducive learning environment, time constraints for co1nduction of Biology practical, students attitude towards the subject, non- coverage of syllabus, and class size among others. All these are just pointing to one singular fact that, something is not right with either the quality of the subject matter or the instructional method adopted.

The performance of secondary school students in Biology in the West African Senior School Certificate Examination (WASSCE) in Ekiti State has not been encouraging, according to the findings of many studies conducted in the recent years, Biology has never achieved an exceptional score line. As a result of this, most parents, knowing that Biology is one of the prerequisite subjects to study science related courses are not happy with this development. Biology is a very important science subject and a requirement for further studies of other science related professional courses such as medicine, agriculture, pharmacy, biotechnology, genetic engineering, among others. Biology is the key to economic, intellectual, sociological, human resource development and well-being of any society.

Based on these assertions of the importance of Biology, there is need for it to be properly taught in the secondary schools to improve students' interest in the subject. It is has been observed that students' performance could be improved if new instructional approaches are adopted by secondary school Biology teachers because, exposing students to the understanding of basic concepts in Biology and achieving desirable learning outcomes requires the use of innovative and interactive instructional approach such as blended learning.

The state of teaching and learning in Nigerian secondary schools calls for review as most of the teachers in public secondary school believe in the use of the traditional talk and chalk method in the classroom. This traditional method of teaching appears to limit the extent to which students and teachers alike can move with the trend of changes in the global world.

According to recent researches, blended learning has the potential to greatly

improve students' academic performance. For instance, Osei and Amponsah, (2023) found that Students' conceptual knowledge and problem-solving abilities improved when online resources were included into traditional Biology classes. Adeyemi & Adeyemo (2022) also posited that, by offering a variety of adaptable learning resources, blended learning has the potential to fill the gaps created by the use of traditional method, to teach Biology. In few Nigerian classrooms, blended learning methodologies have been shown to demonstrate encouraging results. Hence, this study is to investigate the effect of blended learning strategy on senior secondary school students learning outcomes in Biology in Ekiti State, Nigeria.

In a study conducted by Hafeez (2021) on critical review on blended learning versus traditional lecture method, it was revealed that, in most of the studies reviewed, there were significant differences in the academic performance among students taught using blended learning and traditional approaches but blended learning proved to be more effective strategy. The findings of the study conducted by Emmanuel, Bizimana & Mutangana (2022) on performance analysis of Biology education under the implementation of lower secondary school Biology based curriculum policy implication are in alignment with that of Anari (2021) that mean achievement and change in attitude of students taught using blended learning is higher than that of their counterparts. Similarly, Adeleye and Akinnobi (2020) reported that blended learning instructional strategy was an effective strategy of teaching Biology in Ekiti State, Nigeria. Based on the results, it was suggested that teachers should adopt blended learning instructional strategy in the teaching and learning of Biology.

Ugiagben (2024) investigated the impact of blended learning on the academic performance of Basic Science students in Oredo local Government Area of Edo State, Nigeria. It was therefore concluded that, blended learning proved to be more effective in teaching and learning, and also incorporated various learning approaches that make learning more enjoyable. While several studies have examined blended learning in education, few have employed an experimental approach to determine its causal effect on senior secondary school students' learning outcomes in Biology, particularly in Ekiti State, Nigeria. Most existing studies are descriptive or conducted at the tertiary level, leaving a gap in experimentally validated evidence at the secondary school level. This study therefore fills this gap by experimentally investigating the effect of blended learning strategy on Biology learning outcomes among senior secondary school students in Ekiti State.

Objectives of the Study

The objective of this study was to investigate the effect of blended learning strategy on senior secondary school students learning outcomes in Biology in Ekiti State, Nigeria. The study specifically:

- . Investigated the effects of blended learning strategy on senior secondary school students' performance in Biology in Ekiti State.
- ii. examined the attitude of secondary school students toward blended learning in Biology.

Methodology

The study adopted quasi-experimental pre-test, post-test control group design. The pre-test of students' performance in and attitude towards Biology were established on both experimental and control group in other to ascertain their homogeneity. Post-test was administered to measure the effect of the treatment on students' performance and attitude towards Biology. The population for the study consisted of 5,177 Senior Secondary School two (SSS II) Biology students in all 202 public secondary schools across the 16 local Government Areas (LGAs) of Ekiti State. (Source: Ekiti State Ministry of Education, Science and Technology, 2024). The sample of the study comprised 120 Senior Secondary School Two (SSS II) Biology students selected across the three Senatorial Districts in all the 16 local Government Areas in Ekiti State using multi-stage sampling procedure. The first stage was the selection of one Local Government Area (LGA) from each of the three Senatorial Districts, making a total of three Local Government Areas, using simple random sampling technique and two schools were randomly selected from each of the Local Government Areas. Second stage, purposive sampling technique was used to select four schools that have internet facilities and computer laboratories

to give room for one school from urban and rural. Students of the schools selected were assigned to the experimental and control group respectively and used as the sample for the study.

Two research instruments, Biology Performance Test (BPT) and Students Attitudinal Questionnaire in Biology (SAQB) were used to collect data for the study. The Biology Performance Test (BPT) which was drawn from West African Senior Secondary Certificate Examination (WASSCE) past questions comprised 20 questions of multiple choice questions which the respondents were asked to choose the most appropriate option as applied to them. Each correct option chosen was scored one (1) mark while each incorrect response was scored zero (0) mark. The maximum score obtainable was 20 marks.

The second instrument, Students' Attitudinal Questionnaire in Biology (SAQB) consisted of two sections, A and B. Section A sought the demographic information of the respondents such as name of school, gender and class while section B contained 20 items designed to elicit information on the attitude of students towards Biology, in 4-point Likert-type rating scale of Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points; Strongly Disagree (SD) = 1 point. The scoring was reversed for negative statements.

The instruments (BPT and SAQB) were subjected to both face and content validity. The Biology Performance Test BPT was given to two lecturers in Science Education Department who are experts in Biology Education, two lecturers from Test, Measurement and Evaluation within Ekiti State University, Ado Ekiti, and also two experienced Secondary School Biology teachers who are NECO and WAEC examiners for scrutiny. Their corrections, comments and judgments on the clarity of questions and appropriate use of language were strictly adhered to.

The reliability of BPT and SAQB were ascertained by using test re-test method of testing reliability. This was done by administering the instruments BPT and SAQB twice, on 20 students who were not part of the sample within the interval of two weeks, a reliability coefficient of 0.76 was obtained for BPT using Pearson's Product Moment Correlation Analysis and Cronbach Alpha was used to test SAQB which yielded a reliability coefficient of 0.82. These values were regarded high enough to adjudge the instruments as being reliable.

Data Analysis

The data collected for the study were analyzed using descriptive and inferential statistics. All hypotheses generated were tested using inferential statistics. Hypotheses 1, 2, 3 and 4 were tested using t-test and tested at 0.05 level of significance.

Results

1. **Hypothesis 1** There is no significant difference in the pretest mean score of students in the blended learning strategy and those in Conventional group.

Table 1: t-test analysis showing the pre-test score of students' exposed to Blended learning and those taught using conventional method.

Treatment	N	Mean	S.D	Df	T	p
Blended Learning	60	43.69	4.21	118	1.266	0.083
Conventional Method	60	42.67	5.93			

p>0.05

Table 1 showed that t = 1.266, p = 0.083 > 0.05. This implied that the result was not statistically significant, Therefore, the hypothesis was not rejected, implying that there was no significant difference in the pre-test mean score of students' exposed to blended learning and those taught with conventional method. The result revealed that both groups had a comparable performance before treatment, indicating that both the experimental and control groups were homogeneous.

Hypothesis 2: There is no significant difference in the posttest mean score of students exposed to blended learning strategy and those taught using Conventional method.

Table 2: t-test analysis showing the posttest score of students' exposed to Blended learning and those taught using conventional method.

Treatment	N	Mean	S.D	df	t	p
Blended Learning	60	77.58	10.23	118	5.569	0.035
Conventional Method	60	68.00	8.55			

*p<0.05

Table 2 showed that t = 5.569, p = 0.035 < 0.05. This implied that the result was statistically significant. The hypothesis was therefore rejected, which means that students taught with Blended Learning performed better compared to those taught with conventional method after treatment.

Hypothesis 3: There is no significant difference in the attitudinal pretest mean score of students towards blended learning strategy and those in Conventional method

Table 3: t-test analysis showing the attitudinal mean score of students' exposed to Blended Learning and Conventional method before treatment in Biology.

Treatment	N	Mean	S.D	df	t	P
Blended Learning	60	59.45	7.64	118	4.336	0.795
Conventional Method	60	53.28	7.94			

P>0.05

Table 3 showed that t = 4.336, p = 0.795 > 0.05. This implied that the result was not significant. Therefore, the hypothesis was not rejected, implying that there was no significant difference in the attitude of students towards Biology when exposed to blended learning and conventional method before treatment indicating that both groups had comparable attitude towards learning of Biology.

Hypothesis 4: There is no significant difference in the attitudinal posttest mean score of students towards blended learning strategy and those taught using Conventional method.

Table 4: t-test analysis showing the attitudinal mean score of students' exposed to Blended Learning and Conventional Method after treatment in Biology.

Treatment	N	Mean	S.D	df	t	P
Blended Learning	60	80.87	10.11	118	2.736	0.004
Conventional Method	60	67.48	6.42			

*p<0.05

Table 4 showed that t = 2.736, p = 0.004 < 0.05. This implied that the result was significant since. Therefore, the hypothesis was rejected, suggesting that Blended Learning Strategy have more effect on the attitude of students towards Biology compared to conventional method.

Discussion

The findings of this study revealed that there was no significant difference in the pre-test performance of students in both the experimental and control groups indicating a comparable baseline academic performance. This established the homogeneity of the two groups involved in the study prior to the treatment. This implied that the knowledge baseline of the two groups involved in the study were equal. This outcome aligned with the opinion of Creswell and Creswell (2023), who emphasized that establishing equivalence between groups prior to an intervention is essential for attributing post-test differences to the teaching method rather than pre-existing disparities. The similarity in baseline performance suggests that careful grouping effectively controlled for initial academic ability, thereby strengthening the internal validity of the study. This ensured that any subsequent differences recorded afterwards can be confidently linked to the treatment applied. In order words, the difference in the performance and attitude recorded was as a result of treatment applied.

The finding of this study also revealed that blended learning strategy significantly enhanced students' academic performance in Biology compared to the conventional method, as evidenced via the higher mean gain. This suggests that blended learning strategy stimulated students to work collaboratively and productively and enhanced the appeal of the educational activities in the blended learning environment. This result aligned with the finding of Al-Sumaeri (2024) that blended learning strategy enhances academic achievement, motivation and improves students' academic and cognitive performance. The improvement could be attributed to the flexibility nature of blended learning which allows students' to learn at their own pace, space and as well interact with both human and material resources leading to meaningful learning outcomes. Similarly, the finding corroborated that of Tashtoush (2023) who reported significant differences in students' learning outcomes in mathematics and physics before and after the implementation of blended learning. This implied that blended learning can improve academic performance and significantly increase motivation in students.

Furthermore, this finding was also in line with the finding of Adewoyin and Yusuf (2020) who reported that students taught using blended learning strategy performed significantly better than those taught using the conventional method. The improvement was linked to the use of online discussions, and opportunities for independent learning. Similarly, Ogunleye (2019) found that blended learning enhanced students' conceptual understanding of Biology concepts, leading to improved post-test scores compared with pre-test. These findings contradict the hypothesis which states that there is no significant difference in the performance of students exposed to blended learning and those taught using the conventional method.

In addition, the study revealed that the students exposed to blended learning strategy demonstrated a predominantly positive attitude towards Biology as indicated by high percentage in Students' Attitudinal Questionnaire in Biology (SAQB) compared to those taught using conventional method. This implied that students exhibit enjoyment, satisfaction, engagement and confidence in Biology through self- learning. This was in line with the findings of Enwemasor & Charles-Odili (2022), they found that blended learning significantly improved students' attitude towards Biology by promoting collaboration, continuous feedback, and meaningful engagement.

Conclusion

From the findings of this study, it could be concluded that, blended learning strategy was more effective and reliable method of instruction that enhances better performance of senior secondary school students, and improve their attitude towards Biology than Conventional method.

Recommendations

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

i. Biology teachers should make use of blended learning strategy to improve their students'

learning outcomes regardless of gender.

ii. Blended learning strategy should be incorporated formally into the senior secondary school Biology curriculum as a recognized method of teaching various concepts in Biology

iii. Students should cultivate the habit of learning at their own pace with flexible time and space which will assist during Blended learning instruction.

iv. Ministry of education and school administration should organize seminars and workshops for Biology teachers on how to adopt the use of blended learning strategy in teaching Biology.

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BINGO GAME-BASED INSTRUCTIONAL STRATEGY: A PANACEA FOR PUPILS' ACHIEVEMENT IN BASIC MATHEMATICS OPERATIONS

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Abstract

Basic Mathematical Operations (BMOs) are fundamental arithmetic rules in Mathematics which are required to learn all aspects of Mathematics. However, literature revealed that most pupils' does not know how to manipulate these rules and the fear of BMOs is also reported among them. These are largely attributed to the teacher-centred method of deploring the mathematical concepts involving BMOs among primary school pupils. The study was anchored to Lev Vygotsky's Social-cultural Learning Theory, while the pretest-posttest control group quasi-experimental design was adopted. Simple random sampling technique was used to select participants for the study. The instruments used were Mathematics Achievement (r = 0.77) and Pupils' Mental Ability (r = 0.78) test. The data were analysed using Analysis of covariance at p ≤ 0.05. The findings revealed that here was significant main effects of treatment on achievement ($F_{(1;282)}$ = 147.14; partial η^2 = 0.54) The participants in bingo game instructional strategy (BGIS) had higher post-achievement mean score (34.71) followed by those in the control (15.57) group. The result revealed that BGIS enhanced pupils' achievement regardless of their mental ability. It was recommended among others that primary school mathematics teachers should always include games like bingo in the teaching of primary mathematics for better performance.

Keywords: Basic Mathematics Operations, Mathematics game, Bingo game instructional strategy

Introduction

Mathematics is a compulsory subject that is basic to both elementary and secondary education in Nigeria and a prerequisite for gaining admission to virtually all courses in Nigerian tertiary institutions. Mathematics is regarded as a fundamental subject because it is considered to prepare individuals with the basic Mathematical knowledge, skills, values and attitudes necessary for proper functioning in the society.

It is a vast and distinctive branch of knowledge that enables people to realise their own mathematical potential (Harris and Bourne, 2017). It is a subject with many different subfields of study and plays a crucial role in national development. It is a subject that frees a person from chaos and uncertainty, fosters logical reasoning, critical thinking, spatial reasoning, and instills in individuals the required and useful communication skills in their daily lives (Engel *et al*, 2016; Saward , 2017; Yousef, 2022; Abramovich, Grinshpan, and Millagan, 2019; Ohuoha-chidiebere and Ezenwa, 2020; Akinsola, 2023).

All areas of knowledge rely on Mathematics more than ever before to solve problems, formulate theories, and predict consequences. This is because it is a crucial instrument for generating new knowledge. Accountants' understanding of Mathematics allows them to keep track of financial transactions. This is due to the numerous computational tasks that must be completed correctly each time a voucher needs to be prepared (Marion, 2019; Lillian, Gilgert and Samson, 2020; Edeh, 2022). To strengthen the Nigerian economy, Nigeria, like any other developing country moving toward commendable technical growth, needs talented scientists, engineers, and technicians with solid mathematical backgrounds (Powell and Nelson, 2017; Ayuba and Timayi, 2018; Adigun and Sam-Kayode, 2022).

After numeration, basic Mathematics operation takes center stage in elementary school Mathematics. Basic operations involve addition, subtraction, multiplication and division which have application in most advanced mathematical theories. Thus,

knowing them turn into one of the keys to progressing in the comprehension of Mathematics, specifically algebra (Taha and Nese, 2022). These tasks are now much easier to complete with the help of electronic calculators, which can also lead to a dependency that makes grasping Mathematics in its truest sense quite challenging. Calculators can be a useful tool for checking results, but if pupils rely heavily on them, they may miss out on the kind of challenging mental exercises that will help them not only do Mathematics but fully grasp what they are doing (Alper and Halil, 2017; Sidik, Suryadi and Turmudi, 2021). Basic Mathematics operations have significant impact on academic achievement of elementary school pupils while pupils who lack basic mathematical skills struggle with other mathematical courses and their overall academic success.

Ajani and Olabode (2017) found that the performance of Nigerian children in the global numeracy index is not encouraging. Nigeria is ranked below South Africa and Ghana in the elementary education rankings, which are typically based on Mathematics, reading, and science. According to Nwogu (2016), the education sector support programme in Nigeria (ESSPIN) found that pupils in elementary five and six performed poorly in Mathematics and English courses. Number concepts, addition, subtraction, multiplication, and division were the core Mathematics concepts assessed by the ESSPIN. In a field work conducted by Oyeniran (2025) on pupils' performance in Mathematics common entrance examination in some local government in Oyo state, it was discovered that pupils' average performance was below 50%. It was confirmed from the teachers that the cut-off mark for admission to state junior secondary schools out of 100% was 30%.

Teachers are one of the major reasons of Mathematics failure because most of them utilize inadequate teaching methods, and they are unable to make the subject understandable as well as practicable and majority of them have limited understanding of the subject matter (Iren, 2015). It is significant to emphasize that teacher bear majority of the responsibility for the pupils' poor performance in Mathematics at the primary school level during classroom instruction (Akinsola, 2023).

According to Jamie (2018), the utilization of games and other contemporary strategies is likely to significantly influence pupils' understanding of multi-digit addition and subtraction. According to Jamie (2018), upper elementary Mathematics education should adopt a sequence of instruction that progresses from concrete examples to representations and finally to abstract notions. This approach is necessary to ensure that children truly grasp the mathematical concepts and skills they are acquiring. Hui and Mahmud (2023) found that utilizing concrete materials can lead to the effective utilization of notational systems and promote pupils' conceptual development.

The Bingo game is a structured activity where players follow instructions on specially designed cards supplied by the teacher. The game involves participants trying to win within the boundaries set by the regulations. All pupils in the class actively engage in the bingo game, which serves as a motivating tool for them to study and review their previous learning. It functions as an instructional aid for teaching Mathematics, English, and various other disciplines (Rahayu and Widodo, 2016; Russo, Bragg, Russo, and Minas, 2023). Bingo actively involves pupils in the process of teaching and learning. Additionally, it can be employed as a captivating approach to revisiting the previously taught lesson. When the pupils are comfortable, enjoying themselves, and have a strong affinity for the game, it can foster a lively and enjoyable atmosphere for them. Bingo is an exceedingly pleasurable game to engage in with companions.

The game is highly accessible and serves as an effective tool for instructing a wide range of subjects, including Mathematics, history, and foreign language vocabulary. This game is pleasurable to engage in and is a card-matching game in which players match cards with numbers as the caller dials. Players are required to align the numbers on the card with the corresponding numbers on the printed or generated matrix. The card comprises a set of randomly chosen numbers (Tella and Fatoki, 2021; Putri and Kareviati, 2021). Both the entire class and small groups have the opportunity to partake in the game of bingo.

Bingo engrosses pupils' attention, stimulates their involvement in educational activities, and can also serve as an engaging approach to review the taught subject. When children have a sense of comfort and derive pleasure from the game, it can concurrently foster an enjoyable atmosphere (Cinco *et al,* 2021).

This research was based on the socio-cultural learning theory developed by Vygotsky. This theory sees learning as a socio-cultural theory

that explains how human intelligence is initiated in society or culture and makes it applicable to instructional strategy like bingo and game. The key idea of this theory is that social interaction is crucial to the development of cognition. Learning is also a cultural development that is essentially shaped by the use of tools and symbols. In order to foster the growth of cognition, learners are also permitted to collaborate with one another. The importance of adults or peers playing a role in a child's cognitive development is emphasized through a model of the zone of proximal development, which can be used by parents, teachers, caregivers and tutors to structure and accelerate the child's learning outcome.

Statement of the Problem

Most pupils perceived Mathematics as exceptionally tough and this made them to get nervous whenever they need to write tests or examinations in Mathematics. This nervousness which starts from primary school rarely fades away. The teaching methods employed by teachers in teaching Mathematics most especially at the elementary school have been teacher centered and have not given the pupils the opportunity of interacting with themselves and the teaching materials. Moreover, most pupils developed phobia for the subject and considered it to be abstract which led to poor performance of pupils in the subject. A teaching method that involves the use of game will allow pupils to be fully involved in the teaching activities of basic mathematical operations in the elementary school. The use of bingo games for teaching mathematical operation is yet to be fully explored. Previous studies on the impact of game often considered the impacts of two modes of games for teaching other concept apart from basic mathematical operations. Several studies in Nigeria have attempted the use of games to improve pupils' Mathematics achievement but most of these studies used game to teach other aspects of Mathematics without giving exclusive attention to basic mathematical operations and basic operations are mathematical concept that cut across all other mathematical concepts. Based on the foregoing, this study determined the effects of Bingo game-based instructional strategies as panacea for primary school pupils' achievement in basic Mathematics operations in primary schools in Oyo town, Oyo state.

Hypotheses

$H_0$1: There is no significant main effect of treatment on pupils' achievement in basic Mathematics operations.

$H_0$2: There is no significant main effect of mental ability on pupils' achievement in basic
Mathematics operations.

$H_0$3: There is no significant interaction effect of treatment and mental ability on pupils' achievement in basic Mathematics operations

Methodology

This research adopted a quasi-experimental pre-test, post-test Control group design.The population of the study comprised of 520 public primary four pupils in schools in Atiba Local Government Areas of Oyo Town, Oyo State. A multistage sampling was adopted in the study. Six public primary schools who met the successive criteria were simple randomly selected for the study. The primary four class whose: school has completed primary three Mathematics syllabuses as at the time of data collection; school has stable Mathematics teacher; Mathematics teacher was willing to participate in the study. From the list of primary schools which satisfy the criteria, simple random sampling technique was used to select 199 primary four pupils for the study.

Research Instruments

Four research instruments were used for the study, which include two stimuli instruments and two response instruments: The instruments were Instructional guide on bingo games strategy (IGBGS), Instructional Guide on Modified Conventional Method (IGMCM), Basic Mathematic Operation Achievement Test (BMOAT) and Pupils' Mental Ability Test (PMAT)

Instructional Guide on Bingo Games Strategy (IGBGS).

General information like subject, topic, and class are included in this guide. It also included details on the process, activities for the teacher and pupils (such as the bingo game), the curriculum, resources, and overall goals. There were two phases to the guide. A training instructional guide for Mathematics teachers was the first stage, and an experiment examining the use of bingo games to improve learning results was the second. Using oral questions based on the subject delivered, the teacher assessed the class to conclude the lesson. The subjects and instructional objectives were chosen in a way that guarantees the validity of IGBGS. The final draft of the guide was created when it has been trial-tested on 40 primary school pupils who were not part of the study sample.

Instructional Guide on Modified Convectional Method (IGMCM)

The guide's elementary components formed general information, which includes the topic, subject, procedure, overall goals, pupils and teacher activities, weekly contents, and pupil evaluation guide. Experienced Mathematics teachers teaching primary four received the IGMCS to review; all of their recommendations were incorporated into the guide.

Basic Mathematical Operation Achievement Test (BMOAT)

The BMOAT consisted of 40-item multiple choice test with four options. This assessment evaluates pupils' proficiency in performing fundamental mathematical operations, including addition, subtraction, multiplication, and division. The test items were designed in accordance with Bloom's taxonomy of educational objectives, specifically targeting the knowledge, understanding, and reasoning levels of the pupils' cognitive domain.

A preliminary set of 50 items was created and distributed to mathematical experts and primary four Mathematics teachers to assess their face and content validity. The products were given to a group of 40 primary four pupils from a school in Ibadan city who will not be involved in the main study. An item analysis was conducted on the scores to determine the difficulty level and the discriminative potential of each test item. Items with difficulty indices outside the range of 0.40 to 0.70 were removed. Items with difficulty levels above 70% were considered too difficult and items level below 40% were considered too easy and were discarded. The dependability coefficient of the chosen items was calculated using Kuder-Richardson (KR 20) formula. After eliminating ten questions with severe difficulty indices, the test now consists of a total of 40 items. The test has a reliability index of 0.77 and an average item difficulty value of 0.51.

Primary School Pupils' Mental Ability Test (PSPMAT)

The PSPMAT contained 20-items of fill-in the gap questions. Pupils were asked to complete the statement pronounced by the teacher. It was a standardised test from Wechsler pre-school and elementary scale of intelligence. The test items were given to experts in Mathematics education for scrutiny. The 20 item test was administered to 20 primary four pupils outside the local government area of study to test the difficulty indices of the test. The reliability index of 0.68 and an average item difficulty value of 0.54 was obtained.

Two weeks training was done for the participating primary four teachers on the use of bingo games in teaching basic mathematics operations in each of the selected schools. Administration of pretest on BMOAT was done to the pupils by the teachers and researcher after the training. Administration of treatment was later done for the experimental groups and this lasted for eight weeks. Administration of posttest was done to the pupils after the treatment. The data analysis was based on the information gathered from the Basic Mathematical Operation Achievement Test (BMOAT) and the Pupils Mental Ability Test (PMAT). The acquired data were analyzed using inferential statistics, specifically Analysis of Covariance (ANCOVA). The posttest scores were analyzed, with the pretest scores serving as covariates. All hypotheses that have been formulated were tested at a threshold of significance of $p < 0.05$.

Results and Discussions

Table 1: Distribution of the Participants by Treatment and Mental Ability

Variables	Frequency (N)	Percentage (%)
Treatment groups		
Bingo Game Instructional Strategy (BGIS)	95	47.74
Conventional Method (CM)	104	52.26
Total	199	100.0
Mental Ability		
Low	58	29.15
Medium	109	54.77
High	32	16.08
Total	199	100.0

Table1 depicts the findings of the participants by treatment and mental ability. The result revealed that 95 (47.74%) of the participants were under BGIS and CM group were 104 (52.26%). In addition, the mental ability scale revealed that 58 (29.15%) of the participants had high mental ability, 109 (54.77%) had medium mental ability and 32 (16.08%) had low mental ability.

Hypotesis1: There is no significant main effect of treatment on pupils' achievement in basic Mathematics operations.

Table 2: Analysis of Covariance (ANCOVA) of Post-Treatments and Mental Ability

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	134633.617	6	7479.645	793.707	.000	.982
Intercept	21623.660	1	21623.660	2650.236	.000	.915
Post Achievement	16.564	1	16.564	2.030	.155	.008
Treatment	2401.040	1	1200.520	147.138	.000*	.544
Mental Ability	3.039	2	1.519	.186	.830	.002
Treatment x Mental Ability	24.300	3	6.075	.745	.562	.012
Error	2015.309	186	8.159			
Total	200899.000	199				
Corrected Total	20102.502	198				

R Squared = .900 (Adjusted R Squared = .886) * denotes significant p<.05

Table 2 showed that the treatment had a substantial impact on the pupils' achievement in Mathematics basic operations ($F_{(1, 282)}$ =147.14; p<0.05, partial η2 = 0.54). The effect size of 54.0% was revealed in Table 2. In this ANCOVA model, the substantial main effect of the treatment accounted for 54.0% of the total 98.0% variation observed (Adjusted R^2 = 0.98) in pupils' post-treatment scores in Mathematics. Thus, hypothesis 1 was rejected.

This conclusion is consistent with Adesina, Owolabi and Adebayo (2021) study, who found that using the bingo game strategy show a significant main effect of qualitative ability on pupils' achievement. They also suggested that teachers should adopt the bingo game strategy more regularly into their teaching methods, since it has the ability to improve pupils' ability. In their 2016 research, Puput and Sprih emphasised the importance of primary pupils' competency in basic mathematical operations, notably multiplication. The study resulted in a blueprint for a very successful game called "ganbatte incredible" and a Mathematics bingo game for teaching multiplication in primary schools. Potenciano (2018) discovered that playing the bingo number tower game resulted in a considerable increase in pupils' Mathematics learning skills over many weeks. Tella and Fatoki's (2021) research on the effects of the bingo game on Mathematics accomplishment in public elementary schools in Oyo state, Nigeria, revealed a strong Interplay effect between the bingo game and the participants' numeric abilities. This impact favoured high-ability pupils who got the bingo game strategy, since they had higher mean values than their peers in the convetional group.

The poor academic performance of the participants in the traditional technique, as seen by posttest achievement scores, might be linked to the CM's teacher-centered focus. The conclusions of this study are consistent with the work of Russian psychologist Lev Semyonovich Vygotsky in Saul (2023), who believes that learning is a social activity that plays an important part in the development of human intellect. Vygotsky claimed that collaborative learning is essential in the creation of cognition.

Hypothesis 2: There is no significant main effect of mental ability on pupils' achievement in basic Mathematics operations

The results from Table 2 revealed that there was an absence of observable impact of mental ability on pupils' performance in Mathematics. The F-value was .19, indicating a lack of significance (p > .05). The effect

size, measured by partial η2, was .002. Therefore, hypothesis 2 was not negated. This indicates that mental ability did not have any impact on pupils' performance in Mathematics. The analysis in Table 4 presents the Marginal mean estimate, which measures the difference in achievement based on mental ability.

Table 4: Marginal Mean Estimates for Post-Treatment by Pupil Mental Ability

			95% Confidence Interval	
Mental Ability	Mean	Std Error	Lower Bound	Upper Bound
Low	25.04	.35	24.65	26.02
Medium	25.33	.24	25.32	26.26
High	25.79	.53	24.00	26.07

Table 4 showed that pupils with strong mental ability had the highest results (25.79) in Mathematics basic operations compared to pupils with medium (25.33) and low (25.04) mental ability. The order is expressed as low, followed by medium, and then high. This suggests that pupils with high mental ability performed better in Mathematics basic operations compared to those with medium and low mental ability.

The study found that mental ability had no significant overall influence on pupils' performance in Mathematics basic operations. According to Table 4, pupils with high mental ability had the highest scores (25.79) compared to pupils with medium (25.33) and low (25.04) mental ability. This suggests that pupils with high mental ability performed better in than those with medium and low mental ability. This could be unconnected because the treatment provided equitable learning environments for all pupils, regardless of cognitive abilities. This conclusion supports Meral, Derman, and Arzu (2020), who found that there was no significant difference between the pre-test, post-test scores and overall scores of the conventional group.

The observed result contradicts Adeyemi and Awolere's (2016) results, which revealed that mental competency in biology had a significant effect on learners' academic achievement in environmental concepts. Bolaji et al (2016) found that pupils' mental ability, academic self-perception, and scientific temperament were strong predictors of pre-service teachers' performance in basic general Mathematics in Oyo State, Nigeria.

Hypothesis 3: There is no significant interaction effect of treatment and mental ability on pupils' achievement in basic Mathematics operations.

Table 2 showed no significant interaction impact between treatment and mental ability on pupils' achievement in Mathematics basic operations ($F_{(3,279)}$ =.75; p>.05, partial η2 =.012). Hypothesis 3 was thus not rejected. This implies that treatment and mental ability had no impact on pupils' Mathematics basic operations achievement.

The findings revealed that the combined effect of treatment and mental ability on pupils' Mathematics basic operations achievement was not statistically significant. This suggests that mental ability levels (high, medium, and low) are irrelevant; what genuinely determine pupils' success are the fair opportunities provided by both structures. Exposing learners with varied degrees of mental capacity to activity-based strategies will surely result in enhanced performance regardless of the learner's level of mental capability in terms of accomplishment. Duru and Obasi (2023) investigated the relationship between cognitive aptitude and academic performance in Mathematics among senior secondary school two (SS2) pupils. This observation is consistent with the results of that study. It was found that the ability to think critically had an impact on all pupils' academic Mathematics achievement. According to the research, there is no relationship between critical thinking ability and accomplishment level among high achievers.

Conclusion

The research investigated how teaching approches like bingo game instructional strategy has effect on pupils' achievement in basic mathematical operations in Oyo, Oyo state. The effects of mental ability on their comprehension of basic mathematical operations were explored. Three null hypotheses were formulated and tested at a significance level of 0.05. The study used a pre-test, post-test conventional method quasi-experimental design. Furthermore, owing to

the participatory nature of the game strategy, pupils were able to completely comprehend the ideas and solve problems involving basic mathematical operations. According to the findings, the game formats might be used to improve academic performance in many concepts in Mathematics. The study was based on Vygotsky's socio-cultural theory of human learning, which holds that learning is a social process and that society and culture affect human intelligence.

Recommendations

The following recommendations were made based on the results of this study:

i. Mathematics teachers should encourage the use of games, such as bingo in basic Mathematics teaching as this strategy have shown to be quite effective in improving pupils' Mathematics abilities in the subject.
ii. The State Universal Basic Education Board (SUBEB) officers should provide re-training programmes for primary school Mathematics teachers as well as pupils' parents emphasizing the effective use of games like bingo in classrooms. These programmes might take the form of lectures, workshops, or conferences.
iii. Government should be educated on the need to equip schools with game resources, such as bingo cards, to promote regular and successful usage. Furthermore, Mathematics teachers should be encouraged to improvise where necessary.
iv. Curriculum planners should include the concepts that will allow the use of Mathematics games like bingo in the primary Mathematics curriculum.

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UTILIZATION OF SOCIAL MEDIA ACCESSIBILITY ON STUDENTS' ENGAGEMENTS TO LIBRARY REFERENCE SERVICE DELIVERY IN EKITI STATE UNIVERSITY, ADO EKITI

BY

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ABSTRACT

This study investigated the utilization of social media accessibility on students' engagement with library reference service delivery at Ekiti State University. A descriptive survey research design was employed, and the study population comprised undergraduate students across five faculties: Education, Social Sciences, Management Sciences, Science, and Arts. A total of 200 students were selected using stratified random sampling, with proportional representation from each faculty and level. Data were collected using a structured questionnaire and analyzed using descriptive statistics (frequency, percentage, mean) and inferential statistics (Pearson Product Moment Correlation). The findings revealed that a majority of students have moderate to high access to social media, with WhatsApp and Facebook being the most frequently used platforms. Student engagement with library reference services via social media was generally high. The main challenges identified were poor internet connectivity and low digital literacy. Furthermore, a significant positive relationship was found between social media accessibility and student engagement ($r = 0.68$, $p < 0.05$), indicating that greater accessibility enhances participation in library services. The study concluded that social media is an effective tool for enhancing students' engagement with library reference services. It was recommended from the findings that libraries maintain active social media platforms, improve responsiveness, and collaborate with institutional management to enhance internet infrastructure and digital literacy programs.

Keywords: Social Media Accessibility, Student Engagement, Library Reference Services, University libraries, Digital Literacy

Introduction

In today's digital age, social media has revolutionized the way information is accessed, shared, and consumed globally. Its pervasive influence has extended beyond social interactions to become a critical tool in educational settings, especially within academic libraries. Libraries, traditionally seen as physical repositories of knowledge, are rapidly transforming into dynamic digital information hubs that leverage social media platforms to extend their reach and improve user engagement (Makinde & Oyekale, 2025). Social media platforms such as Facebook, Twitter, Instagram, and WhatsApp offer new possibilities for libraries to connect with students, provide timely reference services, and foster collaborative learning environments (Kumar & Patel, 2020). Although, for university students, access to credible and relevant information is fundamental to academic success. Yet, many face challenges including restricted library operating hours and physical access barriers. Through social media, libraries can bridge these gaps, offering reference services that are accessible anywhere and anytime, thereby enriching the student learning experience and supporting their research needs (Bakai et al, 2025). Particularly in Nigerian universities like Ekiti State University, integrating social media into library reference services represents a strategic response to the growing digital literacy and mobile device penetration among students (Adeola & Adesanya, 2021).

Despite the undeniable potential of social media to transform library services, there remains a significant debate regarding its

effective utilization within academic environments. Critics argue that relying heavily on social media risks compromising the quality and reliability of information students receive, pointing to concerns about misinformation and distractions inherent in these platforms (Asuquo et al, 2023). Moreover, there is contention about whether social media can truly replace traditional face-to-face library interactions, which some scholars view as irreplaceable for in-depth academic support (Matthews, 2018).

However, mounting evidence suggests that social media is not merely a supplementary tool but a necessary evolution for academic libraries aiming to meet the changing needs of digital-native students (Rabatseta, 2021). The integration of social media into library reference services can democratize access to information, particularly for students who may face physical or temporal barriers in visiting library spaces (Kumar & Kumar, 2024). Furthermore, social media enables real-time communication and personalized support, fostering greater student engagement and collaborative learning (Kumar & Patel, 2020). Thus, the challenge lies not in rejecting social media as an academic tool but in strategically harnessing its strengths while mitigating its weaknesses. This study argues that understanding the balance between opportunity and challenge in social media use for library services is critical for evolving academic support systems especially in contexts like Ekiti State University, where infrastructure and resource constraints persist alongside increasing digital adoption.

Therefore, this paper intends to explores how social media accessibility influences student engagement with library reference services at Ekiti State University. By examining students' usage patterns, perceptions, and the challenges encountered, this research seeks to provide empirical evidence on social media's role in enhancing academic resource access. Understanding these dynamics is critical for academic libraries striving to remain relevant and effective in the digital era. The findings will offer valuable insights for university libraries on improving service delivery and fostering a digitally inclusive academic community.

Statement of the Problem

Social media's explosive growth has revolutionized communication and information access in learning settings, giving libraries new ways to actively engage students and provide reference services. Libraries are increasingly using social media sites like Facebook, Twitter, and WhatsApp to promptly respond to consumers' information demands. Despite these developments, a large number of students continue to underuse social media-based library reference services.

Even though professional library reference services are available through social media platforms, students in many higher education institutions frequently rely on generic internet searches instead of using them. The usefulness, accessibility, and awareness of social media-based library services are all called into question by this circumstance. Students' engagement may also be hampered by elements including inadequate promotion of library social media services, limited digital literacy, poor internet connectivity and a lack of institutional support.

Furthermore, it is also uncertain whether social media platforms greatly increase students' engagement with reference services, even as libraries invest in them to improve service delivery. Additionally, there is no actual data on how social media accessibility affects how students use library services, especially in developing countries.

Research Objectives

- To determine the level of accessibility of social media platforms for students in accessing library reference services.
- To identify the types of social media platforms used by libraries for reference service delivery.
- To assess the level of students' engagement with library reference services through social media platforms.
- To examine the relationship between social media accessibility and students' engagement with library reference services.
- To identify challenges associated with the use of social media in accessing library reference services among students.

Research Questions

- What is the level of accessibility of social media platforms for students in accessing library reference services at Ekiti State University?
- Which social media platforms are most commonly used by students to access library reference services?
- What is the level of students' engagement with library reference services through social media platforms?
- What challenges do students face in using social media to access library reference services?
- Is there a significant relationship between social media accessibility and students' engagement with library reference service delivery?

Literature Review

Academic libraries are pivotal in advancing knowledge, supporting teaching, learning, and research within universities. The emergence of social media has profoundly reshaped how these libraries engage with their users, including students and faculty. Social media platforms such as Facebook, Twitter, YouTube, and Instagram have become essential tools for extending library reference services beyond the physical library space, enabling timely, interactive and accessible communication with library patrons (Drivas, 2024).

Scholars highlight that social media enhances the visibility and outreach of academic libraries by enabling the promotion of resources, services, and events at low cost and with wide coverage (Quadri, 2024). It facilitates information dissemination, real-time responses to users' queries, and fosters library user engagement, which is critical for meeting the evolving expectations of today's digital-native students (Humphries, 2025). Furthermore, social media creates a virtual community extending the traditional library environment, fostering collaborative learning and social interaction among students and staff (Khan et al, 2025).

Moreover, the application of Technology Acceptance Model (TAM) helps in the Utilisation of Social Media in Library Service Delivery which was developed by Fred Davis in 1989 to explain how users accept and use new technology. The model is widely used in studies involving social media adoption, ICT usage and digital library services. According to Davis (1989), two major factors determine whether users will adopt and utilize a technology: Perceived Usefulness (PU) which refers to the degree to which a person believes that using a particular technology will improve their performance and Perceived Ease of Use (PEOU) which refers to the degree to which a person believes that using a technology will be free of effort.

Thus, when applying TAM to social media utilisation in library services, the model explains how students and library users decide whether to use social media platforms such as WhatsApp, Facebook, Twitter (X), Instagram and Telegram for accessing library services. Therefore, when students find social media useful and easy to use, they are more likely to actively participate in library activities and utilize available services.

Social Media and Its Relevance to Academic Libraries

Social media refers to web-based interactive tools that allow users to create, share, and exchange information in real time. For libraries, these platforms extend service delivery beyond physical boundaries. They allow librarians to disseminate updates, engage students in virtual reference conversations, provide research assistance, and promote electronic resources. Common platforms used in universities are WhatsApp (instant messaging & group reference) (Shittu & Taiwo, 2023), Facebook (service promotion & Q/A), Twitter/X (alerts & virtual desk communication), YouTube (instructional video-based reference), Instagram (visual outreach & announcements) and Email-linked academic platforms (LMS chat features) which is graphically shown in fig. 1 for social networking tools where librarians can interact with users to study their needs and give a feedback, photo sharing where archival pictures can be posted to users or uploaded on the library websites.

Fig.1 Web-based interactive tools for libraries service delivery to create and exchange information.

Library Reference Service Delivery

Reference service is the personal assistance provided by librarians aimed at enabling users to access, retrieve, and use information effectively. Modern reference services integrate digital tools such as: **Virtual reference chat, Ask-a-librarian services, online subject guides** and **Digital resource referral (CLN &** Nonrya, 2026). Social media offers immediacy and informality, enhancing user–librarian interaction beyond traditional counters.

Concept of Student Engagement

Engagement involves behavioral and psychological efforts made by students to participate in academic activities. In library settings: Asking for help, following up on provided resources, Participating in online discussions and providing feedback to librarians. Therefore, social media encourages engagement by reducing intimidation and encouraging help-seeking behaviors. Effective utilization of social media in academic libraries requires thoughtful integration of technology, consistent content creation, and skilled personnel. Library staff training on social media use and content creation is emphasized as vital to attract and sustain student engagement and to provide relevant and user-friendly reference assistance (Meesad & Mingkhwan, 2024). However, several challenges undermine the full potential of social media adoption, especially in Nigerian universities. These challenges include inadequate internet connectivity, erratic power supply, limited digital literacy among library personnel, and poor infrastructural support, which collectively hinder reliable service delivery (Madhusudhan & Soni, 2024).

Despite these challenges, the growing accessibility of mobile devices and digital platforms among students presents a significant opportunity (Nwankwo et al, 2022). Social media platforms are increasingly becoming preferred channels for information seeking and communication, especially outside traditional library hours, thereby enhancing academic productivity and learning experiences (Adeola & Adesanya, 2021). Research specifically focused on Nigerian academic libraries documents that platforms like Facebook and Twitter are predominantly used for library service delivery, while emerging platforms such as YouTube provide dynamic content formats like video tutorials that appeal to modern learners (Nduka et al, 2021). More so, engaging online content, including user training, live reference services, current awareness updates, and interactive discussions, significantly increases students' awareness

and utilization of library resources (Adewojo & Adebara, 2019).

Empirical Review

Scholarly studies both within and outside Nigeria has examined how students' accessibility to social media influences their engagement with libraries, especially reference services. This section reviews key empirical evidence under relevant thematic areas.

Students' Accessibility to Social Media Platforms

Recent studies show that university students possess high access to smartphones and mobile internet, making social media a primary communication channel in academic communities. In a Nigerian study, Adewojo and Momoh (2025) found that more than 80% of students used smartphones as their main tool for information seeking, with WhatsApp, Facebook and Instagram being the most utilized platforms. Similarly, Manj (2024) reported that students' preference for mobile-friendly platforms encourages academic support seeking through social media, particularly when libraries actively promote their digital presence. However, infrastructural challenges persist. Makinde & Oyekale (2025) noted that poor network connectivity and the high cost of internet data negatively affect usage consistency among students in Nigerian universities. This shows that **accessibility alone does not guarantee sustained engagement** if economic and infrastructural barriers remain unaddressed.

Utilization of Social Media for Reference Service Delivery

There is growing empirical support that social media has improved reference service responsiveness. Bakai et al, (2025) found that WhatsApp and Facebook Messenger significantly improved turnaround time for answering student queries in North-Central Nigerian colleges, compared to email and physical reference desks. Ejitagha and Ivwighreghweta (2021) also revealed that Nigerian librarians increasingly use social media to guide students to online journals, e-books, and databases. According to Okunlola (2021), the informal ad interactive nature of messaging encourages students to participate freely without fear of judgment. In South Africa, Rabatseta (2021) observed that students appreciated libraries' availability on platforms they already use daily, showing increased willingness to seek academic assistance.

Therefore, the literature underscores a dual imperative for academic libraries: to embrace social media as a core strategy for service delivery and to overcome infrastructural and capacity barriers through institutional support and policy frameworks. By leveraging the strengths of social media, libraries can sustain their relevance in the digital age and support student success more effectively (Madaki et al, 2025; Nasir & Jana, 2024).

Research Design and Methodology

This study adopts a descriptive survey research design. This design is appropriate because it allows the researcher to gather data from a large group of students to examine the utilization of social media accessibility and its influence on students' engagement with library reference service delivery.

Population of the Study

The population of this study comprises all undergraduate students of Ekiti State University who have access to the university's library services and social media platforms. The university has a diverse student body across several faculties, including Education, Social Sciences, Management Sciences, Science, and Arts, spanning 100 to 400 levels. The total population is estimated to be over 20,000 students, but for the purpose of this study, only students actively enrolled in undergraduate programs and who are potential users of library reference services through social media was considered. Focusing on the population, it ensures that the findings accurately reflect the utilization of social media in engaging students with library reference service delivery.

Sample Size

The sample size for this study was 200 undergraduate students of Ekiti State University. This sample is considered adequate to represent the diverse population of students across faculties and

levels, while also being manageable for effective data collection and analysis. The sample was drawn using a stratified random sampling technique, ensuring proportional representation from all faculties (Education, Social Sciences, Management Sciences, Science and Arts) and levels of study (100 to 400 levels). Stratification ensures that students from smaller faculties or levels are included and that the sample reflects the composition of the university population.

The distribution of the sample is presented in the table below:

Table 1 showing the distribution of the 200 students across faculties and levels at Ekiti State University:

Faculty / Level	100 Level	200 Level	300 Level	400 Level	Total
Faculty of Education	12	13	13	12	50
Faculty of Social Sciences	10	10	10	10	40
Faculty of Management Sciences	10	10	10	10	40
Faculty of Science	10	10	10	10	40
Faculty of Arts	8	7	7	8	30
Total	**50**	**50**	**50**	**50**	**200**

This sample size is sufficient to provide reliable data for statistical analysis, including descriptive statistics (mean, frequency, percentage) and inferential statistics (correlation analysis) to examine the relationship between social media accessibility and students' engagement with library reference services.

Data was collected using a structured questionnaire developed by the researcher. The questionnaire will be divided into sections, including: Section A: Demographic information, Section B: Social media accessibility, Section C: Utilization of social media for reference services, Section D: Students' engagement and Section E: Challenges. Responses were measured using a 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree).

The questionnaire was subjected to face and content validation by experts in library and information science as well as educational research to ensure its relevance and adequacy. A pilot study was conducted using 20 students from a similar institution (not part of the main study) and the responses was analyzed using Cronbach's Alpha, with a reliability coefficient of 0.70. The researcher administered the questionnaire personally and electronically (e.g., Google Forms). Data collected was analyzed using descriptive statistics (frequency, percentage, and mean, standard deviation) to answer research questions and inferential statistics using Pearson Product Moment Correlation (PPMC) to test the relationship between social media accessibility and students' engagement with library reference services.

Results

Demographic Characteristics of Respondents

A total of 200 questionnaires were administered to undergraduate students of Ekiti State University, and all were returned, yielding a 100% response rate. Respondents were distributed across faculties and levels as shown in the sample table.

Table 2: Demographic of Respondents

Faculty	Frequency	Percentage
Faculty of Education	50	25
Faculty of Social Sciences	40	20
Faculty of Management Sciences	40	20
Faculty of Science	40	20
Faculty of Arts	30	15
Total	**200**	**100**

Research Question 1: What is the level of accessibility of social media platforms for students in accessing library reference services at Ekiti State University?

Table 3: Social Media Accessibility

Accessibility Level	Frequency	Percentage (%)
Very High	60	30
High	80	40
Moderate	40	20
Low	15	7.5
Very Low	5	2.5

Respondents were asked about their access to social media for library reference services. The results showed that most students (70%) have moderate to high access to social media, indicating that the majority can potentially use these platforms to engage with library services. Moreover, majority of the students have moderate to high access to social media.

Research Question 2: Which social media platforms are most commonly used by students to access library reference services?

Table 4: Social Media Platforms Used

Platform	Frequency	Percentage (%)
WhatsApp	90	45
Facebook	50	25
X/Twitter	30	15
Instagram	20	10
Others	10	5

Respondents indicated which social media platforms they use for library reference services: WhatsApp was the most commonly used platform, followed by Facebook, suggesting libraries

should prioritize these platforms for service delivery. Therefore, WhatsApp and Facebook are the most commonly used platforms

Research Question 3: What is the level of students' engagement with library reference services through social media platforms?

Table 4: Level of Student Engagement

Engagement Level	Frequency	Percentage (%)
Very High	40	20
High	70	35
Moderate	60	30
Low	20	10
Very Low	10	5

Students' engagement with library reference services via social media was measured using a Likert scale. Most students (55%) reported high to very high engagement, suggesting that social media positively supports their interaction with library reference services. Hence, student engagement with library reference services via social media is generally high.

Research Question 4: What challenges do students face in using social media to access library reference services?

Table 5: Challenges in Using Social Media for Library Services

Challenge	Frequency	Percentage (%)
Poor internet connectivity	70	35
Low digital literacy	50	25
Lack of awareness of library pages	40	20
Limited library responsiveness	30	15
Other challenges	10	5

Internet connectivity and low digital literacy were the major barriers affecting students' engagement. However, the major challenges include poor internet connectivity and low digital literacy.

Research Question 5: Is there a significant relationship between social media accessibility and students' engagement with library reference service delivery?

Table 6: Relationship between Social Media Accessibility and Student Engagement

Variables	r-value	p-value
Social Media Accessibility vs Engagement	0.68	0.001

A Pearson Product Moment Correlation (PPMC) was computed to examine the relationship between social media accessibility and students' engagement with library reference services. The positive and significant correlation ($r = 0.68$, $p < 0.05$) indicates that higher accessibility to social media is associated with increased student engagement in library reference services. Therefore, Social media accessibility has a significant positive relationship with student engagement.

Discussion of Results

The findings of this study provide important insights into how social media accessibility influences students' engagement with library reference services at Ekiti State University. The study revealed that most students (70%) have moderate to high access to social media platforms. This indicates that social media is widely available and can serve as an effective channel for library reference service delivery. This aligns with previous studies which emphasize that high accessibility of digital platforms is a key factor in increasing user engagement with library services (Nwankwo et al, 2022; Norya, 2026). It suggests that students are technologically capable of utilizing these platforms, provided there is adequate guidance and infrastructure. The data showed that WhatsApp (45%) and Facebook (25%) are the most commonly used platforms for library engagement. This finding is consistent with studies by Quadri et al., (2024), who observed that messaging and social networking applications are preferred by students for accessing academic information because of their convenience and familiarity. Libraries, therefore, should prioritize these platforms when designing reference services, ensuring timely responses and regular updates. The study found that the majority of students (55%) reported high to very high engagement with library reference services via social media. This suggests that social media is an effective tool for enhancing student interaction with library staff and resources. The finding supports the view of Shittu & Taiwo (2023) that interactive platforms increase students' willingness to seek information and promote active participation in academic activities. However, the presence of some students reporting low engagement indicates that accessibility alone does not guarantee active use; other factors such as awareness, motivation, and digital literacy also play significant roles. The major challenges identified were poor internet connectivity (35%) and low digital literacy (25%). These barriers highlight the contextual issues that may limit the effectiveness of social media in library service delivery in developing countries. This finding is consistent with Okunlola (2021), who noted that infrastructural limitations and inadequate digital skills often hinder students' ability to fully utilize online library services. Libraries must, therefore, not only provide social media-based services but also support students through training and improved infrastructure. The Pearson correlation analysis revealed a significant positive relationship ($r = 0.68$, $p < 0.05$) between social media accessibility and student engagement. This indicates that students who have better access to social media platforms are more likely to engage actively with library reference services. The result corroborates the Technology Acceptance Model (TAM) theory, which posits that perceived ease of use and access to technology positively influence user engagement and behavior (Davis, 1989). Therefore, enhancing accessibility through reliable internet, mobile-friendly platforms, and user-friendly interfaces can significantly boost student interaction with library services.

Implications of Findings

- Libraries need to maintain active and responsive social media platforms, particularly WhatsApp and Facebook, to maximize student engagement.
- Institutions should invest in improving digital infrastructure and support training in digital literacy to remove barriers to access.
- Future Research could explore other factors influencing student engagement, such as motivation, library promotion strategies, and content relevance on social media.

Conclusion

This study has shown how social media plays a vital role in helping students connect with library reference services at

Ekiti State University. Making library resources more accessible through familiar platforms, students can learn and research better, even beyond the usual library hours. Despite facing challenges like poor internet access and low social media skills among some library staff, the benefits clearly outweigh these hurdles. Moving forward, improving infrastructure and training will help libraries serve students even more effectively. Ultimately, this study highlights that integrating social media into academic support can brighten students' learning journeys and open new doors to knowledge and success. The study concludes that social media accessibility significantly contributes to improved student engagement and enhances the effectiveness, visibility and responsiveness of library reference services at EKSU. Also continued investment in digital-based service delivery will ensure that the library remains relevant in the evolving information landscape and better supports academic success.

This study also examined the utilization of social media accessibility on students' engagement with library reference service delivery. The findings highlight that social media platforms have become essential tools for enhancing communication between libraries and students, offering opportunities for timely, convenient, and interactive reference services. The study concludes that while social media accessibility has the potential to significantly improve students' engagement with library reference services, its effectiveness largely depends on factors such as awareness, digital literacy, internet availability, and the level of responsiveness from library personnel. Although many libraries have adopted social media platforms, students' engagement remains moderate due to challenges such as inadequate infrastructure, limited promotion of services, and varying levels of technological competence.

Furthermore, the study establishes that improved accessibility and strategic utilization of social media can lead to increased student participation, better information-seeking behavior, and enhanced satisfaction with library services. However, without deliberate efforts to address existing barriers, the full benefits of social media in library reference service delivery may not be realized. In conclusion, for libraries to maximize the advantages of social media there is a need for continuous improvement in digital infrastructure, user education and service delivery strategies. By doing so, academic libraries can strengthen their relevance in the digital age and better support students' academic engagement and success

Recommendations

It was recommended that:

- Academic libraries should ensure that their social media platforms are easily accessible by students through mobile-friendly interfaces and consistent internet availability.
- Libraries should intensify awareness campaigns to inform students about available reference services on social media through orientations, workshops and campus-wide announcements.
- Libraries should utilize widely used platforms such as WhatsApp, Facebook, Instagram, and Twitter to reach a broader student population and enhance engagement.
- Librarians should receive regular training on digital communication skills and effective social media management to improve service delivery and responsiveness.
- Institutions should organize training programs to improve students' ability to effectively use social media for academic and information-seeking purposes.
- Library staff should maintain active engagement by responding promptly to students' inquiries and providing personalized assistance through social media platforms.
- Institutions should invest in reliable internet connectivity, power supply and digital tools to support efficient social media-based reference services.
- Libraries should establish policies guiding the use of social media for reference services to ensure professionalism, privacy, and consistency.
- Libraries should continuously assess the effectiveness of social media platforms in service delivery through feedback, analytics, and user satisfaction surveys.

- Libraries should collaborate with academic departments and student bodies to enhance awareness and usage of social media-based reference services.

Contribution to Knowledge

- The study will provide empirical evidence on how social media accessibility influences students' engagement with library reference service delivery, particularly within the context of higher institutions where such studies are still limited.
- It will expand the body of knowledge on digital library services by integrating social media accessibility as a key variable in understanding students' engagement with reference services.
- The study will offer insights specific to developing educational environments (such as Nigerian institutions), where challenges like internet access, digital literacy and infrastructure significantly affect technology adoption.
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ECTRODACTYLY: A RARE LIMB DEFORMITY

BY

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Abstract

Ectrodactyly is a rare congenital limb malformation with median clefts of the hand and hypoplasia or aplasia of the metacarpals and phalanges. This case was an isolated anomaly, non familial sporadic form in unrelated parents with no previous personal or family history of limb or skeletal abnormalities. The index case presented at 7weeks of life with aplasia of the metacarpals and phalanges of the second, third and fourth digits of the left hand. The diagnosis, genetic counselling and management is presented.

Keywords: Ectrodactyly, Congenital, Aplasia, Hypoplasia, Sporadic, Malformation.

Introduction

Ectrodactyly is a rare limb malformation in which a central portion of the hand and digits are missing(Al Rawi et al., 2020; Rayan & Upton III, 2014; Shetty et al., 2014);ectrodactyly, split hand complex, median hypoplasia, lobster claw hand, crab claw hand, typical and atypical cleft hand have been used interchangeably for this limb abnormalities(Rayan & Upton III, 2014). The term ectrodactyly is derived from two greek word ektroma(abortion) and daktylos(finger)(Caicedo et al., 2022), and isoften associated with monodactyly, syndactyly, aplasia and or hypoplasia of the phalanges, metacarpals and metatarsals(Shetty et al., 2014).

The incidence of ectrodactyly is 1:90000(Pindaria et al., 2023) while the prevalence is 1:100000 births(Ruaud et al., 2020), and is usually inherited as an autosomal dominant trait with incomplete penetrance(Ruaud et al., 2020)andaffectation more common in the upper than the lower limbs(Caicedo et al., 2022).Two subtypes are recognized: typical form with absence of metacarpal bones and phalanges with a v-shaped defect and atypical form where the metacarpal bones assume a u-shaped pattern(Caicedo et al., 2022).

The diagnosis of ectrodactyly can be done in utero in the second trimester of pregnancy using 2D ultrasound(Bailess, 2022; Tambawalaa et al.) and with 3D ultrasound with improved image quality in the first trimester of pregnancy(Blitz & Rochelson, 2016). Plain radiograph was utilized in making the diagnosis in the index case at 7 weeks of life.

Case Report

Baby A.Y is a 7week old male infant who was brought to the children out patient department with atypical cleft of the left middle fingers. The infant was a product of parents with no family ties or personal history of skeletal or limb abnormalities.The parents are young adults, mother is a 25year old trader and father a 28year old artisan.

The mother visited the antenatal clinic thrice before delivery and had her routine antenatal drugs. There was no history of any febrile illness, ingestion of alcohol or herbal mixtures during pregnancy

Pregnancy was uneventful with parturition via spontaneous vaginal delivery at term. Birth weight was 3.14kg and physical examination of the infant was essentially normal. The left hand had a median cleft of the central digits (figures 1 and 2), with plain radiograph showing absence of the second to fourth metacarpal and associated phalanges (figure 3), while the right hand was normal (figure 4). Systemic evaluation was essentially normal.

The child was referred to the orthopaedic and plastic unit for consultation and further management. The orthopaedic unit reviewed with routine investigations and plain radiograph of the affected left hand, thereafter the burns and plastic unit reviewed for reconstruction of the structural anatomy.

We report a rare case of non-familial unilateral ectrodactyly of the left hand in a male infant.

Figure 1: Picture of the left hand palmar surface showing median cleft deformity

Figure 2: Picture of the lefthand (dorsal surface) showing lobster claw deformity

Figure 3: Plain radiograph of the left hand showing absence of the 2nd, 3rd, and 4th metacarpals and their associated phalanges

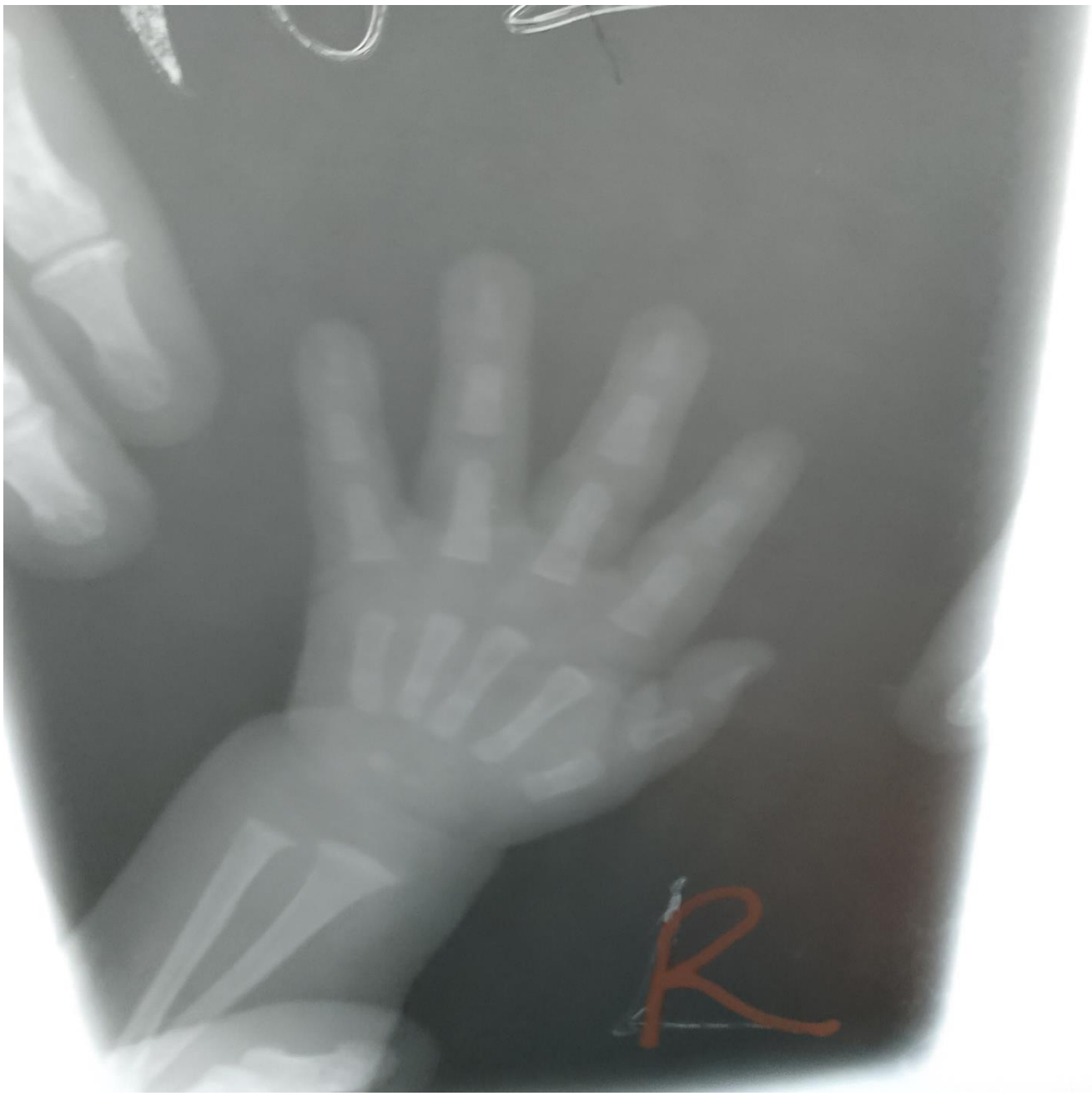

Figure 4: Normal right hand

Discussion

Ectrodactyly result from aberrant development of the hand or foot plates during the seventh week of gestation such that the central rays which form the second, third and fourth digits is defective while the apical ectodermal ridge that leads the differentiation of each ray ceases to function normally(Bailess, 2022; Blitz & Rochelson, 2016). It can be inherited as autosomal dominant, autosomal recessive or X linked depending on the specific genetic mutation pattern(Pindaria et al., 2023; Tambawalaa et al.) and sporadically with no family history(Tambawalaa et al.).

Ectrodactyly occurs in two forms, isolated or as a component of a syndrome(Radu et al., 2023), and any of these two forms can be sporadic or familial with sporadic cases being more common(Blitz & Rochelson, 2016; Durowaye et al., 2011; Kiran et al., 2021).

Chromosomal deletion and duplication are responsible for some cases with anomalies such as tibia aplasia, cranio facial defects and genitourinary abnormalities(Durowaye et al., 2011) and some syndromes such as Carpenter's syndrome, Miller syndrome, Goltz syndrome and Delange syndrome(Durowaye et al., 2011).

The diagnosis of Ectrodactyly can be made in utero (antenatally) or after birth (post natal period). An anomaly ultrasonography in the first trimester with 3Dimensional imaging can detect the cleft digit(s) while a 2Dimensionsal ultrasound with a diligent and patient operator can detect the anomaly in the second trimester.

The diagnosis of the limb anomaly after birth can be detected using a plain radiograph of the affected limb.

The index case presented at seven week of life with left limb anomaly affecting the central digits. The age of the child is evident with the ossification of only one carpal bone, the capitate which is seen in the first three months of life(Hacking, 20 October 2020).

The management of ectrodactly is multidisciplinary involving the radiologist, orthopaedic surgeon, plastic surgeon, physiotherapist, prosthetist and orthotics.

Orthotics help improve the maneuver of the hand with existing fingers whilst a full hand prosthesis is a mechanical solution that improves the range of movement in the upper limb such as wrist and or forearm(Caicedo et al., 2022).

The index case was seen by orthopaedic team, parents were counselled on the management options and given a 6month appointment.

Considerations

Child with ectrodactyly should be evaluated for other congenital anomalies, chest radiograph, plain radiograph, abdominopelvic ultrasound, electrocardiography, 2D echocardiography, genetic analysis should be included in their routine work up examinations. Management involves a multidisciplinary approach for correction of functional disability or improvement and for cosmetic reasons.

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CURRICULUM CONTENT RELEVANCE AS A PREDICTOR OF ENTREPRENEURIAL MINDSET AMONG SENIOR SECONDARY SCHOOL STUDENTS IN OSUN STATE, NIGERIA

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Abstract
This study examined the predictive relationship between curriculum content relevance and entrepreneurial mindset development among senior secondary school students in Osun State, Nigeria. The research addressed the critical gap between Nigeria's entrepreneurship education policy objectives and the measurable dispositional outcomes among secondary school learners. A correlational research design was adopted, with a sample of 384 SS2 students drawn from 20 public secondary schools across three senatorial districts in Osun State using multistage sampling. Data were collected using two adapted and validated instruments: the Curriculum Content Relevance Scale (CCRS; α = 0.87) and the Entrepreneurial Mindset Inventory (EMI; α = 0.91). Three research questions were answered, and one hypothesis was tested at p < 0.05 level of significance using Pearson's Product-Moment Correlation and simple linear regression. The results revealed a statistically significant positive relationship between curriculum content relevance and entrepreneurial mindset (r = 0.682, p < 0.001). Curriculum content relevance accounted for 46.5% (R^2 = 0.465) of the variance in students' entrepreneurial mindset. Students demonstrated moderate levels of entrepreneurial mindset, with opportunity recognition (M = 3.42) and risk-taking propensity (M = 2.98). The findings underscore the necessity for curriculum reform that embeds entrepreneurial competencies across all subjects.

Keywords: Curriculum content relevance, entrepreneurial mindset, senior secondary education, entrepreneurship education, predictor variables

Introduction

The persistent challenge of youth unemployment in Nigeria has reached critical proportions, with recent statistics indicating that over 40% of Nigerian youth remain unemployed (National Bureau of Statistics, 2020). This structural deficiency in the labour market has intensified calls for educational reform that prioritizes entrepreneurial competency development alongside traditional academic achievement. The Nigerian Educational Research and Development Council (NERDC) has responded by deliberately embedding entrepreneurship content into the revised Basic and Senior Secondary Education Curricula, signaling a policy shift from certificate-driven education to one that nurtures creativity, productivity, and problem-solving.

Entrepreneurial mindset is defined as the cognitive and affective orientation that enables individuals to identify opportunities, manage risk, and persist through setbacks has emerged as a crucial outcome of contemporary secondary education (Alao, Njoku, Hamzat & Omopariola, 2024). Research has demonstrated that entrepreneurial intention among Nigerian adolescents is significantly influenced by contextual factors including family environment, self-efficacy, and proactive personality and relies on activity-based learning, mentorship, and exposure to real-life experiences (Ereh, Ini, & Ikpo, 2019). However, the specific role of curriculum content relevance in shaping this mindset remains inadequately explored, particularly at the senior secondary school level. This is cultivated through entrepreneurship and business education programs embedded within the secondary school curriculum, as guided by the *National Policy on Education, (FRN, 2025)*.

Osun State, located in Southwestern Nigeria, presents a unique context for this investigation. The state has implemented various educational reform initiatives, yet youth unemployment remains a pressing concern. Understanding how curriculum content relevance predicts entrepreneurial mindset among Osun State students could inform targeted interventions and policy decisions.

Statement of the Problem

Despite Nigeria's national policy directives emphasizing entrepreneurship education, evidence suggests that the intended outcomes are not being fully realized. Graduates of secondary schools continue to demonstrate job-seeking orientations rather than opportunity-recognition competencies. The gap between curriculum intentions and learner outcomes has been attributed to implementation challenges, including inadequate teacher preparation, resource constraints, and by critical consideration, the perceived irrelevance of curriculum content to students' lived realities and future aspirations. The problem this study addresses is the lack of empirical evidence establishing the relationship between how students perceive the relevance of their curriculum content and their development of entrepreneurial mindset attributes. Without such evidence, curriculum developers and educators lack direction for meaningful reform and transformation.

Research Questions

This study was guided by the following research questions:

(1) What is the level of curriculum content relevance as perceived by senior secondary school students in Osun State?
(2) What is the level of entrepreneurial mindset among senior secondary school students in Osun State?
(3) To what extent does curriculum content relevance predict entrepreneurial mindset among senior secondary school students in Osun State?

Research Hypothesis

One research hypothesis was formulated at tested at 0.05 level of significance:

H_0 1: There is no significant relationship between curriculum content relevance and entrepreneurial mindset among senior secondary school students in Osun State.

Conceptual Framework

Curriculum Content Relevance refers to the degree to which students perceive their academic content as meaningful, applicable to real-life situations, and connected to their future career aspirations. In the context of entrepreneurship education, relevant content is characterized by practical orientation, contextualisation to local economic realities, and integration of experiential learning opportunities. The Nigerian Educational Research and Development Council (NERDC) has emphasized that curriculum must equip young people with "the knowledge, skills, and values needed to create solutions, generate wealth, and build a better society" (NERDC, 2025).

Entrepreneurial Mindset encompasses the cognitive and affective dispositions that predispose individuals toward entrepreneurial action. Drawing from the experiential learning framework, Suyaman et al. (2026), conceptualise entrepreneurial mindset as comprising opportunity recognition, creativity and innovation, risk-taking propensity, proactiveness, and self-efficacy. These dimensions are not innate but can be cultivated through structured educational experiences. In Nigeria, this mindset is developed through entrepreneurship and business education programs embedded within the secondary school curriculum, as proposed by the National Policy on Education (FRN, 2025).

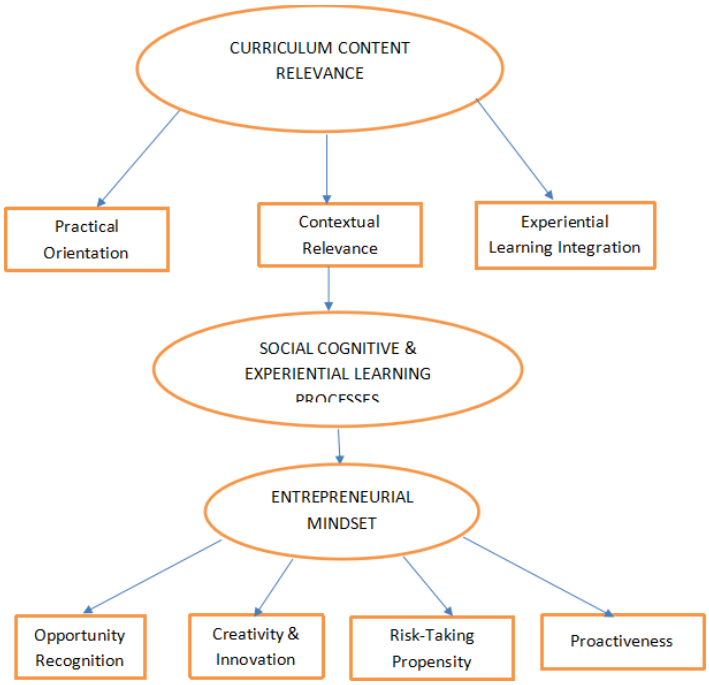
Theoretical Framework

This study is anchored in two complementary theories which are:

Social Cognitive Theory: This theory posits that learning occurs through the interaction of personal, behavioural, and environmental factors *(Bandura, 1986)*. Curriculum content serves as an environmental stimulus that interacts with students' cognitive processes to shape entrepreneurial self-efficacy and outcome expectations. Bandura's (1986) *social cognitive theory* provides a foundation for understanding how students cultivate entrepreneurship behaviour through observation, practice, and reinforcement in educational environments.

Experiential Learning Theory: Kolb's four-stage cycle posits concrete experience, reflective observation, abstract conceptualization, and active experimentation which provide a pedagogical foundation for entrepreneurship education. Research has revealed that experiential learning models significantly enhance both entrepreneurial mindset and character among secondary school students (Kolb, 1984). According to Alao et al. (2024), the entrepreneurial mindset is cultivated via experiential learning methods like projects, simulations, and hands-on activities which transcend rote instruction.

Figure 1: Conceptual Framework Showing the Relationship between Curriculum Content Relevance and Entrepreneurial Mindset



Empirical Review

Research on entrepreneurship education in Nigerian secondary schools has gained momentum in recent years. Ohadiugha (2023), examined curriculum development impact on entrepreneurship skills among Nigerian university students, finding significant differences in entrepreneurial mindset between public and private institutions, and recommending collaborative curriculum development involving stakeholders.

At the secondary level, Saibu et al. (2024), investigated students' perceptions of Entrepreneurial-Motivated Approach (EMA) in chemistry teaching in Lagos State. Their findings revealed that EMA enhanced both conceptual understanding and entrepreneurial self-reliance skills compared to traditional lecture methods. This study recommended subject-based entrepreneurship integration across all secondary subjects. The implementation of entrepreneurial studies curricula at the senior secondary level has been explored by Ursula (2025), who looked into the role of NERDC's 34 trade/entrepreneurial curricula in promoting human and economic development aligned with Sustainable Development Goals. The research pointed out that effective implementation is central to achieving youth empowerment and sustainable peace.

Internationally, Suyaman et al. (2026), developed and validated an experiential learning-based entrepreneurship model (PEIR which connotes Prepare, Experience, Internalize, Reflect) for senior secondary school students. Their research demonstrated moderate improvements in entrepreneurial mindset through structured experiential learning cycles within institutional frameworks. Despite these contributions, no study has specifically examined curriculum content relevance as a predictor of entrepreneurial mindset among senior secondary school students in Osun State, justifying the present investigation.

Methodology

This study adopted a correlational research design. This design was suitable for examining the relationship between two variables (curriculum content relevance and entrepreneurial mindset) and determining the predictive power of the independent variable (curriculum content relevance) on the dependent variable (entrepreneurial mindset). The target population comprised all 48,672 Senior Secondary School Two (SSS2) students in public secondary schools in Osun State (Source: Osun State Ministry of Education, 2025). SSS2 students were selected because they have completed at least one year of the senior secondary curriculum and can provide informed responses regarding curriculum content relevance Using Yamane's formula, a sample size of 384 students was determined. Multistage random sampling technique was used. Three Local Government Areas (LGAs) were randomly selected from each senatorial district. This gave a total of nine LGAs. Two secondary schools were then randomly selected from each LGA making a total of 18 schools. From each selected school, 22 SSS2 students were selected using simple random sampling technique. Two instruments were developed for data collection. They are: Curriculum Content Relevance Scale (CCRS) and Entrepreneurial Mindset Inventory (EMI).

The CCRS measured students' perceptions of their curriculum content relevance across three domains: practical orientation (8 items), contextual relevance (7 items), and experiential learning integration (5 items). Items were structured on a 4-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), Strongly Disagree (1).

The EMI measured entrepreneurial mindset across five dimensions: opportunity recognition (6 items), creativity and innovation (6 items), risk-taking propensity (5 items), proactiveness (5 items), and entrepreneurial self-efficacy (6 items). The same 4-point Likert scale was used.

Both instruments were subjected to face and content validation by three experts in educational psychology and measurement. Reliability was established through a pilot test involving 50 SSS2 students from a school not included in the main study (from neighboring Oyo State). Cronbach's alpha coefficients were 0.87 for CCRS and 0.91 for EMI, indicating high internal consistency.

Research questions were answered using mean and standard deviation. The hypothesis was tested using Pearson Product-Moment Correlation (PPMC) and simple linear regression at 0.05 significance level. For mean scores, a benchmark of 2.50 was adopted as the criterion for agreement (scores ≥ 2.50 indicate positive perception/agreement; scores < 2.50 indicate negative perception/disagreement).

Results

Research Question 1: Level of Curriculum Content Relevance

Table 1: Mean and Standard Deviation of Curriculum Content Relevance Perceptions

Domain	N	Mean	SD	Remark
Practical Orientation	384	2.86	0.74	Positive
Contextual Relevance	384	2.73	0.81	Positive
Experiential Learning Integration	384	2.51	0.79	Positive
Overall CCRS	384	2.70	0.65	Positive

*Note: Benchmark mean = 2.50

The results from sample distribution across senatorial districts indicate that students perceive curriculum content as moderately relevant (overall mean = 2.70). Practical orientation had the

highest mean (2.86), while experiential learning integration had the lowest (2.51), suggesting that while students see practical value in their subjects, opportunities for hands-on, experiential learning are limited.

Research Question 2: Level of Entrepreneurial Mindset

Table 2: Mean and Standard Deviation of Entrepreneurial Mindset Dimensions

Dimension	N	Mean	SD	Remark
Opportunity Recognition	384	3.42	0.58	High
Creativity and Innovation	384	3.18	0.62	High
Proactiveness	384	3.05	0.71	High
Entrepreneurial Self-Efficacy	384	3.01	0.68	High
Risk-Taking Propensity	384	2.98	0.76	Moderate
Overall EMI	384	3.13	0.59	High

Table 2 reveals that students demonstrate a high overall entrepreneurial mindset (mean = 3.13). Opportunity recognition scored highest (3.42), reflecting students' ability to identify business opportunities in their environment. Risk-taking propensity scored lowest (2.98), suggesting that Nigerian secondary students remain relatively risk-averse.

Figure 2: Bar Chart Showing Entrepreneurial Mindset Dimension Scores

Research Question 3: Predictive Power of Curriculum Content Relevance

Table 3: Simple Linear Regression Summary **on Curriculum Content Relevance**

Model	R	R^2	Adjusted R^2	Std. Error of Estimate
1	0.682	0.465	0.464	0.432

Table 4: ANOVA for Regression Model

Model	Sum of Squares	df	Mean Square	F	p-value
Regression	60.234	1	60.234	322.456	< 0.001
Residual	69.366	382	0.187		
Total	129.600	383			

Table 5: Regression Coefficients

Variable	B	Std. Error	Beta (β)	t	p-value
Constant	1.487	0.124		11.992	< 0.001
Curriculum Content Relevance	0.608	0.034	0.682	17.956	< 0.001

The regression analysis reveals that curriculum content relevance significantly predicts entrepreneurial mindset ($\beta = 0.682$, $t = 17.956$, $p < 0.001$). The R^2 value of 0.465 indicates that curriculum content relevance accounts for 46.5% of the variance in entrepreneurial mindset among senior secondary school students. The regression equation is:

Entrepreneurial Mindset = 1.487 + 0.608(Curriculum Content Relevance)

This means that for every one-unit increase in curriculum content relevance perception, entrepreneurial mindset increases by 0.608 units.

Research Hypothesis 1: There is no significant relationship between curriculum content relevance and entrepreneurial mindset among senior secondary school students in Osun State

Table 6: Pearson's Product-Moment Correlation Analysis

Variable	N	Mean	SD	r	p-value	Remark
Curriculum Content Relevance	384	2.70	0.65	0.682	< 0.001	Significant
Entrepreneurial Mindset	384	3.13	0.59			

*Correlation is significant at $p < 0.01$ level (2-tailed)

Table 6 shows a strong, positive, and statistically significant correlation between curriculum content relevance and entrepreneurial mindset ($r = 0.682$, $p < 0.001$). Therefore, the null hypothesis (H_0) which states that there is no significant relationship between curriculum content relevance and entrepreneurial mindset among senior secondary school students in Osun State is rejected, and the alternative hypothesis which states that there is significant relationship between curriculum content relevance and entrepreneurial mindset among senior secondary school students in Osun State is accepted. This indicates that students who perceive their curriculum content as relevant tend to demonstrate higher levels of entrepreneurial mindset.

Discussion

The finding revealed that students perceive curriculum content as moderately relevant (mean = 2.70) aligns with previous research indicating that while Nigerian educational policies emphasize relevance, implementation gaps persist. The lower score for experiential learning integration (2.51) is particularly noteworthy, as experiential learning has been identified as a critical mechanism for developing entrepreneurial competencies. This suggests that the NERDC's vision of shifting from "certificate-driven to one that nurtures creativity, productivity, and problem-solving" has not been fully realized at the classroom level in Osun State. Students demonstrated high overall entrepreneurial mindset (mean = 3.13), with opportunity recognition scoring highest (3.42). This finding is consistent with Salami (2019) research among Oyo State adolescents, which found significant entrepreneurial intention influenced by contextual factors. The relatively low risk-taking propensity score (2.98) may reflect cultural values that prioritize security and predictability, as well as the absence of structured opportunities for calculated risk-taking within the school environment.

The strong positive correlation ($r = 0.682$, $p < 0.001$) between curriculum content relevance and entrepreneurial mindset provides empirical support for the theoretical framework. This finding corroborates the work of Ohadiugha, (2026) who found that curriculum development significantly impacts entrepreneurship skills, and Saibu et al. (2024), who demonstrated that entrepreneurial-motivated approaches enhance both learning and self-reliance skills.

The 46.5% variance explained by curriculum content relevance ($R^2 = 0.465$) shows that while curriculum relevance is a powerful predictor, other factors such as family environment, peer influence, self-efficacy, and proactive personality identified by Salami, (2019) also contribute to entrepreneurial mindset development.

Conclusion

This study has established that curriculum content relevance is a significant predictor of entrepreneurial mindset among senior secondary school students in Osun State, Nigeria. The strong positive relationship between these variables underscores the importance of curriculum design and implementation in shaping students' entrepreneurial dispositions. While students demonstrate moderate perceptions of curriculum relevance and high entrepreneurial mindset, the limited integration of experiential learning represents a missed opportunity for enhancing entrepreneurial competency development.

Recommendations

Based on the findings, the following recommendations are made:

The NERDC and Osun State Ministry of Education should revise the senior secondary curriculum to embed entrepreneurial competencies across all subjects, not only in stand-alone entrepreneurship courses. Subject-based entrepreneurship integration, as piloted in chemistry education, should be expanded to mathematics, sciences, arts, and vocational subjects.

Schools should be required to allocate specific time for experiential learning activities, including project-based assignments, business simulations, and community engagement projects. The PEIR (Prepare, Experience, Internalize, Reflect) model validated by Suyaman et al. (2026), provides an evidence-based framework for implementation.

Teachers must receive training on entrepreneurial pedagogy, including how to make curriculum

content relevant to students' local contexts and future aspirations. As the NERDC Executive Secretary emphasised, "the objectives of the new curriculum will not be achieved without effective teachers in the classroom".

Schools should establish partnerships with local businesses and entrepreneurs to provide mentorship opportunities, internships, and real-world problem-solving experiences for students.

Schools should create safe environments for calculated risk-taking, including business plan competitions, mini-enterprise projects, and innovation challenges that normalize failure as a learning process.

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SPATIAL VISUALIZATION SKILLS AS PREDICTOR OF STUDENTS' PERFORMANCE IN SEMICONDUCTOR CONCEPT USING VISUAL LABORATORY SIMULATIONS IN SECONDARY SCHOOLS IN BAYELSA STATE

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Abstract

This study investigated spatial visualization skills as predictor of students' performance in semiconductor concept using Visual laboratory Simulations in secondary schools in Bayelsa State. A correlational research design within a quantitative framework, complemented by a pretest–posttest quasi-experimental approach, was adopted. The sample comprised 120 SS3 Physics students selected through purposive sampling, with intact classes randomly assigned to experimental (n = 53) and control (n = 67) groups. The experimental group received instruction using VLS, while the control group was taught using the Traditional Teaching Method (TTM). Two validated instruments which are Spatial Visualization Skills Test (SVST) and Physics Achievement Test on Semiconductor Concepts (PATSC) were used for data collection. Reliability coefficients were 0.87 (KR-20) and 0.84 (Cronbach's Alpha) respectively. Data were analyzed using Simple Linear Regression and Analysis of Covariance (ANCOVA) at the 0.05 significance level. Results showed that spatial visualization dimensions significantly predicted students' performance, $F(5,114) = 16.72$, $p < .001$, $R^2 = .423$. ANCOVA revealed a significant difference between groups, $F(1,117) = 31.77$, $p < .001$, partial $\eta^2 = .220$, with the VLS group outperforming the TTM group. The study concluded that visual laboratory simulations enhance understanding of abstract semiconductor concepts.

Keywords: Performance, Semiconductor, Predictor, Spatial Visualization Skills, Visual Laboratory Simulations.

Introduction

Physics plays a fundamental role in driving technological and scientific advancement by providing the foundational principles that explain the behavior of matter, energy, and the forces that govern the universe. From classical mechanics and electromagnetism to modern quantum physics, the discipline underpins nearly every scientific and engineering innovation. The laws of Physics are at the heart of technologies such as electricity generation, telecommunications, aviation, and medical imaging (Aderonmu & Agbesor, 2025). Its systematic approach to problem-solving and emphasis on experimentation cultivate analytical and critical thinking skills essential for innovation. Thus, nations that prioritize Physics education often lead in technological development, as the discipline fuels industries such as electronics, robotics, nanotechnology, and renewable energy.

Understanding abstract Physics concepts, such as semiconductors, is particularly vital for students in science and engineering fields, as these concepts form the basis of modern technological applications. Semiconductors are the building blocks of electronic devices, including transistors,

diodes, solar cells, and integrated circuits, which drive the global digital economy (Tolasa, 2025). Mastery of such topics equips learners with the conceptual tools to innovate and solve real-world technological problems. However, because semiconductor concepts involve microscopic processes like electron flow and energy band transitions, students often struggle without effective instructional support. Developing a deep conceptual understanding of these abstract phenomena enables future scientists and engineers to apply theoretical principles to the design and development of advanced technologies. Students often encounter significant challenges in visualizing microscopic and abstract phenomena in semiconductor physics because these concepts involve processes that are invisible to the naked eye and occur at the atomic or subatomic level. Understanding ideas such as electron flow, energy band structures, charge carrier movement, and the formation of p-n junctions requires learners to mentally represent dynamic interactions that cannot be directly observed or easily demonstrated using traditional teaching methods. According to Kunwar, et al., (2022), many students struggle to connect theoretical explanations with real-world applications due to the abstract nature of these phenomena, leading to misconceptions and rote learning. The lack of concrete visual aids or interactive experiences further complicates comprehension, as learners find it difficult to imagine how electrons move through materials or how energy levels determine conductivity, thus weakening their conceptual understanding and problem-solving ability in semiconductor topics. Spatial visualization skills are multidimensional cognitive abilities that enable individuals to mentally process and manipulate spatial information.

Table 1

Dimensions of Spatial visualization skills

Dimension	Description	Example in Physics Learning
Spatial Relations	Perceiving relative positions of objects	Understanding how semiconductor layers are arranged
Mental Rotation	Rotating objects mentally to see new views	Visualizing current paths in rotated circuit diagrams
Spatial Orientation	Understanding position and direction	Determining electron flow direction in a p–n junction
Spatial Visualization	Mentally transforming or reconstructing shapes	Visualizing electron-hole interactions or crystal structures
Spatial Perception	Interpreting spatial relationships from different viewpoints	Reading and interpreting 3D Physics models or diagrams

According to Muffato, et al., (2022); Soares, et al., (2022;) Lowrie, et al.,(2017), spatial visualization can be described across several core dimensions or components.

(i) Spatial Relations: This dimension refers to the ability to quickly and accurately perceive the relationships between objects in space. It involves recognizing how shapes or figures relate to each other when moved or rotated. For instance, students use spatial relations when visualizing how electrons move within a semiconductor lattice or across a p–n junction.

(ii) Mental Rotation: Mental rotation is the ability to mentally turn or rotate two- or three-dimensional objects to understand how they would appear from different angles. In Physics, this helps learners visualize structural changes in diagrams or circuits when viewed from different perspectives.

(iii) Spatial Orientation: This involves understanding how objects are positioned relative to oneself or within a given space. It focuses on maintaining one's sense of direction and orientation while objects move or change position. For example, it helps students interpret vector directions or current flow diagrams in semiconductor physics.

(iv) Spatial Visualization (Complex Manipulation): This broader dimension

entails the multi-step manipulation of spatial information, including folding, unfolding, transforming, or reconstructing shapes mentally. It requires reasoning through complex spatial transformations, such as understanding the interaction between multiple components in an electric circuit or crystal structure.

(v) Spatial Perception: Spatial perception relates to the ability to understand spatial relationships despite changes in one's orientation or viewpoint. It is vital for interpreting 3D diagrams, schematic representations, and cross-sectional views commonly found in Physics and engineering illustrations.

Spatial visualization is a crucial cognitive ability that allows individuals to mentally manipulate, rotate, and interpret two-dimensional (2D) and three-dimensional (3D) representations of objects or phenomena, enabling them to understand spatial relationships and transformations (Atit & Rocha, 2020). In science and engineering education, this skill supports learners in visualizing abstract and complex concepts such as molecular structures, circuit diagrams, or force interactions that cannot be easily perceived through direct observation. According to Tomai (2023), students with strong spatial visualization skills tend to perform better in STEM disciplines because they can translate symbolic information into mental images and reason effectively about spatial configurations. In Physics, particularly in topics like semiconductor physics, spatial visualization helps students imagine electron flow, crystal lattice structures, and energy band transitions, thereby enhancing comprehension, problem-solving, and innovation in technologically driven fields.

Visual laboratory simulations are interactive, technology-driven instructional tools designed to replicate real-world physical experiments and visualize abstract scientific concepts in a dynamic, engaging manner. Platforms such as PhET Interactive Simulations, Crocodile Physics, and Multisim provide learners with virtual environments where they can manipulate variables, observe outcomes, and test hypotheses in real time. These simulations bridge the gap between theory and practice by translating abstract equations and microscopic phenomena into observable, manipulable visual models. Hurd et al., (2021) noted that simulations promote active learning by allowing students to explore cause-and-effect relationships, receive instant feedback, and build conceptual understanding without the limitations of physical laboratory resources or safety concerns.

Visual laboratory simulations enhance accessibility and deepen comprehension, especially in Physics topics that are challenging to demonstrate through traditional instruction, such as semiconductors, electromagnetism, and quantum mechanics. By enabling learners to visualize phenomena like electron flow, energy band transitions, and current-voltage relationships, these digital tools make invisible processes visible and tangible. They also foster student-centered learning, where learners can experiment at their own pace and develop critical thinking and inquiry skills. Research by Jhon et al., (2022) affirmed that simulation-based learning not only improves conceptual understanding but also boosts students' motivation and engagement, making it a vital pedagogical innovation for 21st-century science education.

Integrating spatial visualization skills with visual laboratory simulations offers a powerful approach to bridging the gap between abstract theoretical knowledge and conceptual understanding in semiconductor physics. While spatial visualization enables students to mentally manipulate and interpret complex spatial relationships, visual simulations provide concrete, interactive representations of otherwise invisible phenomena such as electron flow, energy bands, and p–n junction behavior. The combination allows learners to actively construct mental models of microscopic processes and test their understanding in a dynamic, feedback-rich environment. Adeoye and Ogedengbe (2023) opined that the integration of cognitive skill development with technology-based visualization fosters deeper learning, as students are better able to connect symbolic equations with visualized processes, leading to improved comprehension and performance. This synergy between mental and technological visualization not only enhances retention but also develops critical thinking and problem-solving abilities essential for success in advanced science and engineering fields.

Statement of the Problem

Despite the recognized importance of Physics in scientific and technological advancement, students' achievement in the subject has continued to decline, particularly in abstract areas such as semiconductor physics. Many learners struggle to grasp complex microscopic concepts like electron flow, energy bands, and p–n junction formation due to limited spatial reasoning abilities and inadequate access to well-equipped laboratories. The lack of hands-on experiences and visual representation of these invisible phenomena often leads to rote learning rather than conceptual understanding. Consequently, students find it difficult to relate theoretical knowledge to practical applications, resulting in persistent misconceptions and poor academic performance in semiconductor-related topics.

Traditional teaching methods commonly used in Physics classrooms further compound the problem. Instruction often relies heavily on verbal explanations, abstract mathematical derivations and theoretical descriptions, which neglect the visual and spatial dimensions necessary for meaningful understanding. This teacher-centered approach limits learners' ability to mentally visualize dynamic physical processes making it difficult to comprehend complex relationships within semiconductor materials. As a result, many students lose interest in Physics and perform below expectation, particularly in concepts that require strong spatial cognition and visualization.

While the introduction of visual laboratory simulations has shown promise in improving students' conceptual understanding and engagement, there remains a critical research gap regarding how individual differences in spatial visualization skills influence learning outcomes when such tools are used. Specifically, the extent to which students' spatial visualization abilities predict their performance in semiconductor concepts through visual simulations is yet to be adequately explored in the Nigerian secondary educational context. Understanding this relationship is essential for developing effective instructional strategies that integrate cognitive skill development with technology-enhanced learning, ultimately improving Physics achievement and fostering deeper scientific understanding among students.

Aim and objectives of the study

The aim of this study is to investigate the predictive influence of spatial visualization skills on students' performance in semiconductor concepts when taught using visual laboratory simulations. Specifically, the objectives of the study are to;

(i) examine whether spatial visualization skills significantly predict performance outcomes in semiconductor learning.
(ii) determine the mean performance of students' taught semiconductor concepts using the Visual Laboratory Simulations and Tradition Teaching methods.

Research Questions

The following research questions were raised for the study.

1. To what extent do spatial visualization skills predict students' performance in semiconductor concepts when taught using visual laboratory simulations?
2. What is the mean performance of students' taught semiconductor concepts using the Visual Laboratory Simulations and Tradition Teaching methods?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

Ho_1: Spatial visualization skills (Spatial Relations, Mental Rotation, Spatial Orientation, Spatial Visualization and Spatial Perception) do not significantly predict students' performance in semiconductor concepts taught using visual laboratory simulations.

Ho_2: There is no significant difference between the mean score of students' taught semiconductor concepts using the Visual Laboratory Simulations and Tradition Teaching methods

Methodology

This study adopted a correlational research design within a quantitative framework, complemented by a pretest–posttest quasi-experimental approach. The correlational aspect aims to determine the predictive

influence of students' spatial visualization skills on their performance in semiconductor concepts, while the quasi-experimental component evaluates how the use of visual laboratory simulations affects students' learning outcomes. This design is appropriate because it enables the researcher to establish both the strength and direction of the relationship between cognitive ability (spatial visualization) and academic performance in an authentic learning environment.

The population of this study consisted of all Senior Secondary School Three (SSS III) Physics students in public secondary schools offering Physics in Yenegoa Local Government Area of Bayelsa State, Nigeria. This level is chosen because students in SSS III are typically taught semiconductor concepts as part of the senior secondary Physics curriculum.

A sample of 120 students were selected from two secondary schools using a purposive sampling technique selected based on the availability of Physics teachers and computer facilities for simulation-based learning. Intact classes were randomly assigned into experimental and control groups each comprising about 53 and 67 students respectively. The experimental group received instruction using Visual Laboratory Simulations, while the control group was taught using conventional methods (Traditional Teaching Method).

The instrument for data collection was the Spatial Visualization Skills Test (SVST) and Physics Achievement Test on Semiconductor Concepts (PATSC). The SVST was a standardized test designed to measure students' ability to mentally manipulate and interpret two- and three-dimensional objects. The test consisted of items adapted from established spatial ability instruments of the Revised Purdue Spatial Visualization Test (Yoon, 2011). PATSC is researchers' developed test that was designed to assess students' knowledge, comprehension and application of semiconductor principles such as energy bands, p-n junctions, diodes and transistors. It consisted of 20 multiple-choice items with four options each (A-D).

The instruments were subjected to content and face validity by three experts in Physics Education, Educational Technology and Measurement and Evaluation. Their feedbacks were used to refine the content, language and structure of the instruments to ensure they measure the intended constructs. A pilot test was conducted using 15 SS3 Physics students from a school not involved in the main study. Data from the pilot was analyzed using the Kuder-Richardson Formula 21 (KR-21) for the multiple-choice achievement test and Cronbach's Alpha for the spatial visualization test for internal consistency. A reliability coefficient of 0.87 and 0.84 were obtained respectively.

The procedure for data collection was conducted in three main phases: Phase I (Pre-Testing), Phase II (Treatment or Instructional Phase) and Phase III (Post-Testing). During the Phase I (Pre-Testing), both the experimental and control groups were administered the Spatial Visualization Skills Test (SVST) and the Physics Achievement Test (PATSC) before instruction to establish baseline equivalence. In Phase II (Treatment or Instructional Phase) the experimental group was taught selected semiconductor topics (e.g., energy bands, diodes, and transistors) using the Visual Laboratory Simulation Package (VLSP). The (VLSP) is the instructional intervention developed using simulation software such as PhET Interactive Simulations and Crocodile Physics. The VLSP provided virtual demonstrations of semiconductor behaviors, including current flow and diode operation through interactive animations. The control group was taught the same content using the Traditional Teaching method, consisting of oral explanations, textbook examples and board illustrations.

During Phase III (Post-Testing) immediately after the treatment, both groups were re-administered the Physics Achievement Test (PATSC). The scores from the posttest were used to compare the pretest results to determine learning gains.

The data for the study was tested using Simple Linear Regression Analysis and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Result

Hypotheses

Ho_1: Spatial visualization skills (Spatial Relations, Mental Rotation, Spatial Orientation, Spatial Visualization and

Spatial Perception) do not significantly predict students' performance in semiconductor concepts taught using visual laboratory simulations.

Table 2

Multiple Linear Regression Analysis Showing the Predictive Influence of Spatial Visualization Skills on Students' Performance in Semiconductor Concepts.

Coefficients	Under standardized Coefficients	Standardized Coefficient		t	Sig.
	Beta	Std. Error	Beta (β)		
(Constant)	12.57	2.45	—	5.13	.000
Spatial Relations	0.31	0.09	.29	3.44	.001
Mental Rotation	0.22	0.08	.21	2.75	.007
Spatial Orientation	0.17	0.07	.16	2.43	.017
Spatial Visualization	0.26	0.10	.20	2.61	.010
Spatial Perception	0.19	0.08	.18	2.38	.019

Source: Researchers' field work, 2026.

A multiple linear regression analysis as shown on Table 2 was conducted to examine whether the dimensions of spatial visualization skills such as Spatial Relations, Mental Rotation, Spatial Orientation, Spatial Visualization and Spatial Perception significantly predicted students' performance in semiconductor concepts taught using visual laboratory simulations. All five predictors made unique, statistically significant contributions to the model. Specifically, Spatial Relations (β = .29, p = .001), Mental Rotation (β = .21, p = .007), Spatial Orientation (β = .16, p = .017), Spatial Visualization (β = .20, p = .010), and Spatial Perception (β = .18, p = .019) each significantly predicted students' performance in semiconductor concepts.

Table 3

ANOVA and Model summary showing the predictive influence of Spatial Visualization Skills on Students' Performance in Semiconductor Concepts.

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Regression	1534.21	5	306.84	16.72	.000
Residual	2093.47	114	18.36		
Total	3627.68	119			
R = .650					
R^2 = .423					
Adjusted R^2 = .398					
Std. Error of the Estimate = 4.28					

Source: Researchers' field work, 2026.

Table 3 indicated that the overall regression model was statistically significant, F(5, 114) = 16.72, p < .001, indicating that the combination of spatial visualization dimensions significantly predicted students' performance. The model explained approximately 42.3% of the variance in students' performance (R^2 = .423, Adjusted R^2 = .398), suggesting a moderate predictive relationship. These results indicate that students with stronger spatial visualization abilities tend to perform better

in understanding abstract semiconductor topics when learning through visual laboratory simulations. Thus, the null hypothesis stating that spatial visualization skills do not significantly predict students' performance in semiconductor concepts was rejected.

Ho_2: There is no significant difference between the mean score of students' taught semiconductor concepts using the Visual Laboratory Simulations and Tradition Teaching methods

Table 4

Analysis of Covariance (ANCOVA) Summary Showing the Effect of Instructional Method on Students' Performance in Semiconductor Concepts

Source of Variation	Sum of Squares	Df	Mean Square	F	Sig. (p)	Partial η^2
Covariate (Pretest)	287.64	1	287.64	6.81	.010	.057
Group (Teaching Method)	1342.21	1	1342.21	31.77	**< .001**	.220
Error	4931.18	117	42.13			
Total	15640.00	120				
Corrected Total	6550.92	119				

Source: Researchers' field work, 2026.

An analysis of covariance (ANCOVA) was conducted as shown in Table 4 to compare the effectiveness of Visual Laboratory Simulations (VLS) and Traditional Teaching Methods (TTM) on students' performance in semiconductor concepts, while controlling for pretest achievement. After adjusting for pretest scores, a significant difference was found between the two groups, $F(1, 117) = 31.77$, $p < .001$, partial $\eta^2 = .220$. This indicates that the type of instructional method had a large effect on students' performance.

Table 5

Adjusted Posttest Means and Standard Errors of Students' Performance by Instructional Method

Group	N	Adjusted Mean	Std. Error
Visual Laboratory Simulations (VLS)	53	68.47	0.94
Traditional Teaching Method (TTM)	67	59.32	0.87

Source: Researchers' field work, 2026.

The analysis in Table 5 revealed that the adjusted mean posttest score for students taught with Visual Laboratory Simulations ($M = 68.47$, $SE = 0.94$) was significantly higher than that of students taught with Traditional Teaching Methods ($M = 59.32$, $SE = 0.87$). These results suggest that Visual Laboratory Simulations were more effective in improving students' understanding of semiconductor concepts than Traditional Teaching Methods. Therefore, the null hypothesis stating that there is no significant difference between the mean score of students taught semiconductor concepts using Visual Laboratory Simulations and Traditional Teaching Methods was rejected.

Discussion of Findings

The findings of this study revealed that students taught semiconductor concepts using Visual Laboratory Simulations (VLS) significantly outperformed those taught using Traditional Teaching Methods (TTM), even after controlling for pretest differences. This suggests that interactive, technology-driven instruction enhances conceptual understanding in abstract Physics topics such as semiconductors. The higher adjusted mean score of the VLS group indicates that visualization and interactivity enable students to better

connect theoretical ideas to observable representations, thereby improving comprehension and retention. This result aligns with earlier findings by Shedrack, et al., (2024) where it was reported that computer-based visual simulations foster deeper conceptual engagement and help students overcome misconceptions in Physics.

The observed significant effect of the instructional method further shows the importance of active and multimodal learning environments in science teaching and learning. Visual laboratory simulations, such as PhET and Crocodile Physics, provide dynamic representations of otherwise invisible phenomena like electron flow and energy band transitions making abstract concepts more accessible. According to Ngu (2019), such visual representations help students mentally manipulate physical systems, bridging the gap between symbolic representations and real-world meaning. Similarly, Chernikova (2020) emphasized that simulation-based learning promotes scientific reasoning by allowing students to test, observe and revise their conceptual models in real time, an experience that traditional lecture-based approaches rarely provide.

The findings also demonstrated that students' spatial visualization skills significantly predicted their performance in semiconductor concepts when using visual simulations. This implies that learners with stronger abilities to mentally rotate, manipulate and interpret spatial information are more capable of understanding the microscopic interactions that occur within semiconductors. This result corroborates the assertion of Kyaw and Vidóković (2025) that spatial skills are crucial predictors of achievement in STEM disciplines, as they support problem-solving, model interpretation and reasoning about three-dimensional systems. In the context of Physics, where much of the content is abstract and symbolic, spatial reasoning provides the cognitive scaffolding that enables meaningful visualization of invisible phenomena.

This result strengthens the argument for integrating simulation-based tools into Physics instruction to foster both spatial reasoning and conceptual understanding. Amil & Buensuceso (2025) similarly reported that simulations are most effective when used as complements to guided inquiry and hands-on learning, as they engage learners cognitively and visually. The implication of this finding is that Physics educators, especially in developing contexts like Nigeria, should adopt interactive simulations to compensate for inadequate laboratory infrastructure while promoting deeper conceptual learning and student engagement.

Conclusion

This study concluded that the use of Visual Laboratory Simulations (VLS) significantly enhanced students' understanding and performance in semiconductor concepts compared to the Traditional Teaching Method (TTM). The interactive and visual nature of simulations allowed learners to engage more deeply with abstract and microscopic phenomena such as electron flow and p-n junction formation. By providing dynamic representations and immediate feedback, simulations transformed passive learning into an active cognitive process that promotes conceptual change. The findings also confirmed that spatial visualization skills play a critical role in predicting students' success in understanding semiconductor physics, suggesting that learners with stronger spatial abilities can more effectively interpret and manipulate complex visual information.

The results underscore the importance of integrating technology-enhanced and spatially oriented instructional strategies in Physics education, particularly in contexts where laboratory resources are limited. The combination of spatial reasoning and visual simulations provides a powerful pedagogical framework for improving conceptual understanding and bridging the gap between theory and practice. Therefore, fostering spatial skills and adopting simulation-based learning can enhance students' engagement, improve learning outcomes, and prepare them more effectively for careers in science, technology, engineering, and mathematics (STEM).

Recommendations

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

1. Physics teachers should integrate visual laboratory simulations into classroom instruction to enhance conceptual understanding of abstract topics like semiconductors and improve students' performance.

2. Curriculum planners and educational policymakers should incorporate spatial visualization training into Physics curricula to strengthen students' cognitive skills necessary for learning abstract and technical concepts.

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EFFECTS OF ROTATION-BASED BLENDED LEARNING MODEL ON MATHEMATICS ACHIEVEMENT AND SELF-STUDY SKILLS AMONG SECONDARY SCHOOL STUDENTS

BY

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Abstract

This study examined the effectiveness of a blended learning model on mathematics achievement and self-study skills among secondary school students in Ekiti State, Nigeria. The study was motivated by persistent difficulties in students' mathematical understanding, problem-solving performance, and independent learning habits, particularly within conventional teacher-centred instructional settings. A pretest–posttest quasi-experimental design was adopted. The sample comprised 95 Senior Secondary II students drawn from two intact classes in an urban secondary school using purposive sampling technique. Data were collected using a 40-item Mathematics Achievement Test and a 20-item Self-Study Skills Scale, with reliability coefficients of 0.79 and 0.85 respectively. Descriptive statistics and analysis of covariance were used to analyse the data. Findings showed that students exposed to blended learning recorded higher gains in mathematics achievement than those taught through conventional instruction, with the experimental group improving from a pretest mean of 61.25 to a posttest mean of 85.14. Similarly, self-study skills improved markedly among students in the blended learning group, rising from a mean of 3.12 to 4.18. The findings suggest that a carefully structured blended learning model supported by teacher guidance and purposeful digital activities can strengthen the achievement and self-study skills among secondary school learners of mathematics.

Keywords: blended learning, mathematics achievement, self-study skills, secondary school students, rotation model.

Introduction

Mathematics is a core subject in secondary school yet many students continue to face problems in understanding concepts, problems solving and motivation, resulting in either poor performance and limited development of self-regulated learning (Egara, 2024; Sбez-Delgado et al., 2023). These difficulties are particularly consequential at the senior secondary school level, where students are expected to prepare for internal and external certification examinations while also preparing them for future participation in STEM pathways. It has been observed by the researchers that in many secondary school classrooms, Mathematics instruction remain largely teacher centred with lessons

often emphasizing demonstration, note copying, textbook exercise and teacher-controlled practices. While, these approaches may support content coverage, they often do not provide sufficient opportunities for differentiated learning, repeated practice, independent exploration of mathematical ideas and immediate feedback. Moreover, students who require additional time to process abstract concepts may fall behind while those who need more challenging tasks may also not adequately covered. Similarly, the development of self-study skills such as goal setting, time management, resource use, persistence and self-assessment do not often receive explicit attention with these approaches whereas these skills are important skills that should not be overlooked at this level of education (Зobanoğlu & Gıkalp, 2026; Maoto, 2023). This has spurred researchers to take a look at novel pedagogies such as blended learning to improve content understanding and learner autonomy (Egara, 2024; Abdissa et al., 2025; Komala & Monariska, 2023).

Blended learning is a method that combines traditional teaching and online teaching in ways that maintain the effectiveness of classroom learning while providing opportunities for self-paced learning, practice, and feedback (Ahmed 2025, Yu et al 2025). Blended learning in mathematics can help with the use of visual representations, interactive practice, quizzes, explanation through videos, collaborative problem solving as well as differentiated reinforcement. This model allows the students to have access to digital resources for use as a way of independently exploring while at the same time having direct guidance from the teacher, as well as peer-to-peer interaction in the classroom. This may help to address some of the common issues in mathematics education such as lack of engagement, limited personalization, and difficulties in developing autonomous learning habits (Attard & Holmes, 2020; Tong et al., 2022). The model is particularly promising when experience in digital activities is not used as a substitute for teaching, but as part of a deliberate pedagogical design that improves explanation, practice, assessment, feedback, and engagement.

The rotation model is one of the blended learning modalities for secondary school contexts with limited arrangements. With respect to this model the student switches between classroom lead by a teacher and organised digital or self-paced learning stations. As a result, the teacher can still provide useful instruction while students work independently with the digital material, worksheets, quizzes, and collaborative learning tasks. In resource poor settings, the rotation model can be easier to implement compared to fully online or highly flexible models because devices, internet access, and teacher supervision can be organised in the school ecosystem.

In many schools, access to digital devices, stable internet connectivity, electricity, and quiet home study spaces cannot be assumed. At the same time, students increasingly encounter digital technologies in informal learning and examination preparation. A blended model that is school-supported and teacher-mediated may therefore provide a more equitable way of introducing digital learning into mathematics instruction.

Existing studies suggest that blended learning can improve mathematics achievement and related learner outcomes. Tong et al. (2022), found that a blended learning approach improved students' achievement, self-study skills, and learning attitudes in secondary mathematics. Abdissa et al. (2025) similarly reported positive effects of a lab rotation blended learning model on secondary school students' mathematics achievement. In Nigeria, Egara and Mosimege (2024) found that blended learning improved learners' mathematics achievement and retention. Meta-analytic evidence also indicates that blended learning can have positive effects on mathematics performance, although the magnitude of the effect varies according to implementation model, educational level, digital platform, and instructional quality (Putri, 2025; Setiawan et al., 2022).

The self-study skills (independent learning, time management, use of resources and self-assessment) are very important at secondary level because students prepare for examination and other learning requirement necessary for life (Зobanoğlu & Gıkalp, 2026; Maoto, 2023). Conventional teaching strategies, which are often controlled by a teacher are usually ineffective in developing these skills. Studies (Abdissa et al., 2025; Egara &

Mosimege, 2024) conducted in various developing countries and regions within secondary mathematics contexts reveal that blended learning results in greater achievement and retention than other traditional approaches. The effect sizes imply they possess substantial practical significance. Various meta-analytic reviews have also confirmed that blended learning is effective in improving mathematics performance at all educational levels the secondary level. However, heterogeneity exists because of the way the blended learning was implemented (Wu et al., 2025; Putri, 2025).

The primary purpose of this study was to determine whether the use of a blended learning model has an effect on the achievement and self-study abilities of second-year students in mathematics compared with face-to-face learning. For this purpose, a research question was raised and two hypotheses were formulated.

Research Question: To what extent does rotation-based blended learning models affect mathematics achievement and self-study skills among secondary school students relative to conventional classroom instruction?

Hypotheses

1: There is no significant difference in pretest and post-test mathematics achievement scores of students taught mathematics using rotation-based blended learning models and those taught using traditional methods.

2: There is no significant difference in pretest and posttest self-study skills scores of students in the experimental and control groups

Literature Review

Blended learning refers to the intentional combining of face-to-face instruction with online or digitally-facilitated learning experiences (Graham, 2006; Hrastinski, 2019). The essence of blended learning is not merely to deploy technology in the instruction but to craft experiences that integrate teacher explanation, learner self-directedness, peer interaction, instant feedback and digital resources. In mathematics education, effective integration can be particularly valuable, as many students benefit from repeated practice, visual representations, detailed explanations, diagnostic feedback, and opportunities to revisit challenging concepts independently (Tong et al., 2022; Abdissa et al., 2025; Egara, 2024).

Various blended learning models have been successfully used in school mathematics. Some of these models include flipped model, flex model, and the Lab or station rotation model. In the flipped classroom model, students view instructional video or materials ahead of class time and class time is devoted to problem solving, discussion and application. For the flex model, online learning is the primary mode of instruction, with teachers offering support when necessary. In the lab rotation or station rotation model, students switch between teacher-led learning and digital learning or self-directed lesson activities (Mahjudin et al., 2021). The current study emphasizes upon the rotation model since this model is more practicable at secondary schools where the digital devices could be shared and teacher intervention is still considerably required.

Blended Learning and Achievements in Mathematics

Most research findings indicate that blended learning can enhance the mathematics achievement of learners if the design is appropriate and instructionally aligned. According to Tong et al. 2022, students who are taught through a blended learning model perform better in mathematics achievement rather than conventional instruction. Their research discovered that not only did students' self-study skills improve, but their learning attitude as well. Hence, blended learning may affect the cognitive and affective dimensions of learning mathematics. Abdissa et al. (2025) reported similar evidence in Ethiopia, where students on a lab rotation blended learning model attained significantly higher mathematics scores than students on a traditional classroom group. Similarly, Al-Ali (2024) shared that Jordanian high school students made significant gains in achievement and knowledge retention in a blended learning intervention. Also, the prior research of Lin et al. (2017) revealed that its use in the junior high had a positive impact on mathematical performance and attitude. According to Egara and Mosimege (2024), learners in secondary school taught by means of blended learning had better achievement and retention of Mathematics than those taught through conventional method. This

is significant as it suggests that blended learning does not only work in environments where technology is abundant but may work in the African context where technology is lacking. However, the success of these models depends on the quality of instructional planning, the conditions of access, teacher competences and the digital task-curriculum fit.

Blended learning had a positive effect on students' mathematical ability (Setiawan et al. 2022). Furthermore, Putri (2025) illustrated that blended learning has a considerable overall positive effect on mathematics achievement, and this was evident in the empirical studies. Outcomes may differ depending on learning platform, school level, duration of intervention, topic of mathematics, preparation of teacher and fidelity of implementation. The workings of a particular blended model in a particular context can only be ascertained through localized classroom-based studies.

Blended Learning and self-study skills.

Successful mathematics learning requires self-study skills so students can practice alone, make use of learning resources, manage time, evaluate solutions and rectify misconceptions. There exists a strong relationship between these skills and self-regulated learning. In typical classrooms, students may depend on the teacher's explanations and seldom have the opportunity to plan/monitor their learning. In contrast, blended learning can offer opportunities to engage independently with materials or online quizzes, worksheet feedback and revision tasks.

According to Tong et al. (2022), blended learning was found to enhance students' self-study skills because students were obliged to interact with learning materials outside of ordinary lesson explanation. The blend-learning environments were reported to support self-regulated and self-directed learning skills (Uz and Uzun, 2018). In addition, a meta-analysis carried out by Guntur and Purnomo (2024) shows positive impacts of self-regulated learning interventions in online and blended environments. Zhao et al. (2025) provided additional evidence that self-regulated learning strategies are related to academic performance in online and blended learning.

Literature reveals that blended learning often positively influences fostering learner attitudes, motivation and engagement towards mathematics. According to Tong et al. (2022) and Lin et al. (2017), the ability to attend classes flexibly as well as interact with peers efficiently in a blended environment enhanced the learning attitudes and reduced the anxiety levels of online learners. Moreover, students in mixed groups reported more satisfaction, greater confidence, and more intrinsic motivation due to the self-paced practice and multimedia resources (Attard & Holmes, 2020).

It appears that blended learning can influence study behaviours of learners which further enhance their performance in mathematics. Mathematics concepts are more likely to be secured by students who learn to manage their time, go back over explanations, attempt practice questions, use feedback and monitor their own progress. The benefits are dependent on the way the blended model is implemented. When left to their own devices online, students in blended learning may reproduce or deepen existing inequalities. If students participate in formal, supervised digital activities, which are associated with classroom support and promote blended learning, they are likely to get better study habits.

Implementation Issues in Resource-Constrained Contexts

The effectiveness of blended learning cannot be separated from implementation conditions. UNESCO (2023) cautions that educational technology should be judged not by novelty, but by relevance, equity, scalability, and sustainability. In resource-constrained contexts, students may differ widely in access to devices, internet connectivity, electricity, and home study support. Teachers may also differ in digital competence and confidence. These conditions matter because blended learning can either broaden access to learning opportunities or widen inequalities if poorly planned.

For this reason, school-supported rotation models may be especially useful. They allow digital learning to occur under teacher supervision and within scheduled learning time. Students can share school-based devices or rotate through stations, reducing dependence on home access. The teacher remains available to clarify misconceptions and provide support. Such

a model is not a technology replacement strategy; it is a pedagogical arrangement that uses digital resources to strengthen explanation, practice, feedback, and student responsibility.

Gap in the Literature

The reviewed literature indicates that blended learning can improve mathematics achievement and may support self-study skills. However, three gaps justify the present study. First, there remains a need for more context-specific evidence from Nigerian secondary schools. Second, fewer studies examine achievement and self-study skills together. Third, blended learning studies sometimes use broad labels without clearly identifying the specific model implemented. This study contributes by evaluating a rotation-based blended learning model in a Nigerian secondary school and by examining both mathematics achievement and self-study skills using a quasi-experimental design.

Methodology

The study used a quasi-experimental pretest-posttest non-equivalent control group. Two intact classes were selected: one as the experimental group and the other as the control. The sample consisted of 95 students aged 14–17 years. Two intact classes were purposively sampled from an urban secondary school to avoid disruption and ensure practicality. The experimental group was treated using a rotation-based blended learning model. During each instructional cycle, students moved between teacher-led classroom instructions and structured self-paced learning activities. The digital component included instructional videos, online or offline quizzes, worksheets, guided practice tasks, and discussion prompts. The face-to-face component included teacher explanation, worked examples, small-group problem solving, feedback, and individual support. The control group were taught conventionally over the same eight-week period. To support uniformity, both groups covered the same mathematics content and received equivalent instructional time.

Two instruments were used for data collection: the Mathematics Achievement Test and the Self-Study Skills Scale. The Mathematics Achievement Test was a 40-item multiple-choice test developed from the secondary school mathematics curriculum and the topics covered during the study. MAT was reviewed by mathematics education experts for content validity, curriculum alignment, clarity, and appropriateness for Senior Secondary II students. A pilot test was conducted before the main study, and a test re-test reliability coefficient of 0.79 was obtained.

The Self-Study Skills Scale was a 20-item Likert-type questionnaire designed to measure students' independent learning behaviours. The scale covered goal setting, time management, resource use, persistence, self-monitoring, and self-assessment. Responses were scored on a five-point scale ranging from strongly disagree to strongly agree. Higher scores indicated stronger self-study skills. The instrument was reviewed for face and content validity and pilot-tested for internal consistency. Cronbach's alpha was .85, indicating acceptable reliability.

Data were analysed using descriptive statistics and analysis of covariance. Means, standard deviations, mean gains, and within-group effect sizes were used to describe changes in mathematics achievement and self-study skills. ANCOVA was used to test the hypotheses because it allowed comparison of posttest scores between the experimental and control groups while controlling for pretest scores. The experimental group was treated using a rotation-based blended learning model. During each instructional cycle, students moved between teacher-led classroom instructions and structured self-paced learning activities. The digital component included instructional videos, online or offline quizzes, worksheets, guided practice tasks, and discussion prompts. The face-to-face component included teacher explanation, worked examples, small-group problem solving, feedback, and individual support. The control group were taught conventionally over the same eight-week period. To support uniformity, both groups covered the same mathematics content and received equivalent instructional time.

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Results

Descriptive analysis

Research Question: To what extent does the implementation of rotation-based blended learning model affect mathematics achievement and self-study skills among secondary school students relative to conventional classroom instruction?

To assess the extent to which the implementation of rotation-based blended learning model affect mathematics achievement and self-study skills among secondary school students, the results of the pretest and posttest scores of the students in the experimental group were compared with the results of students in the control group descriptively. As shown in Table 1, the pretest results indicate that the experimental and control groups were generally similar prior to the intervention. With regards to the mathematics achievement, pretest mean of the experiment group was 61.25 (SD = 7.82) and the control group was 60.98 (SD = 7.65). The control and experimental group having a mean score of 3.08 (SD = 0.71) and 3.12 (SD = 0.68) respectively on the pretest of self-learning skills.

Table 1: *Pretest and Posttest Descriptive Statistics for Mathematics Achievement and Self-Study Skills*

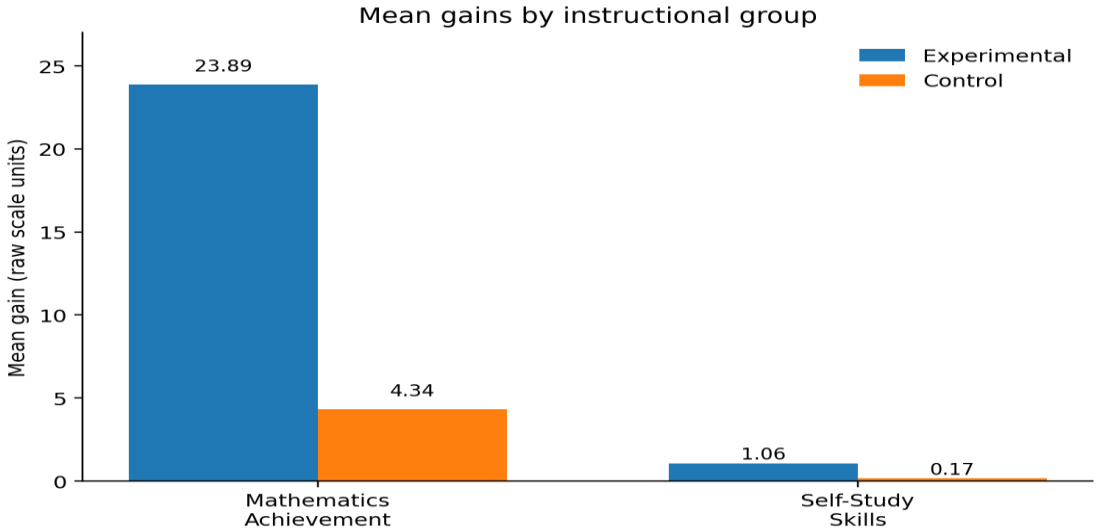
Variable	Group	N	Pretest M (SD)	Posttest M (SD)	Mean gain	Within-group d
Mathematics achievement	Experimental	48	61.25 (7.82)	85.14 (10.95)	23.89	2.41 (very large)
Mathematics achievement	Control	47	60.98 (7.65)	65.32 (9.18)	4.34	0.50 (medium)
Self-study skills	Experimental	48	3.12 (0.68)	4.18 (0.72)	1.06	1.50 (large)
Self-study skills	Control	47	3.08 (0.71)	3.25 (0.69)	0.17	0.24 (small)

After the testing, the experimental group improved a lot more than the control group. As far as mathematics achievement was concerned, the experimental group was found to increase from 61.25 to 85.14 which result in a mean gain of 23.89 points whereas the control group was found to increase from 60.98 to 65.32 which result in a mean gain of 4.34 points. The within-group Cohen's d values were 2.41 (experimental group) and 0.50 (control group), showing very large

improvement in the blended learning condition and medium improvement in the conventional classroom condition, respectively. The result of the study - For self-study skills, the experimental group's score increased from 3.12 to 4.18 with a mean gain score of 1.06. The score of the control group increased from 3.08 to 3.25 with a mean gain score of 0.17. The blended learning group experienced a large effect of blended learning on self-regulation skills (d = 1.50), while the control group experienced a small effect (d = 0.24).

The two outcomes produced average gains as shown in Figure 1. The pattern suggests that learning in a blended mode has resulted in better enhancements in both math achievement and self-study skills. The difference in performance was particularly significant, with the experimental group gaining on average a score of 19.55 points greater than the control group's score. The experimental group's mean gain on self-study skills exceeded that of the control group by 0.89 scale points. Therefore, according to the description above, the cognitive and learner-autonomy results were well-substantial due to the blended learning model.

Figure 1: *Mean Gains in Mathematics Achievement and Self-Study Skills by Instructional Group*



Hypothesis Testing

Test of Homogeneity

Before conducting ANCOVA, independent-samples t-tests were conducted on the pre-test scores to determine whether the experimental and control groups were statistically equivalent at baseline. This was necessary because ANCOVA assumes that groups are reasonably comparable before the treatment, with the pre-test serving as the covariate. The result is presented in table 2.

Table 2: Independent-Samples t-Test for Pre-test Equivalence of Experimental and Control Groups

Variable	Group	*N*	Mean	SD	*T*	df	*p*	Cohen's *d*	Decision
Mathematics Achievement	Experimental	48	61.25	7.82	0.17	93	.865	0.03	Not significant
	Control	47	60.98	7.65					
Self-Study Skills	Experimental	48	3.12	0.68	0.28	93	.780	0.06	Not significant
	Control	47	3.08	0.71					

The results in Table 2 show that there was no statistically significant difference between the experimental and control groups in Mathematics Achievement pretest scores, t(93) = 0.17, p = .865. Similarly, there was no statistically significant difference between the groups in Self-Study Skills pretest scores, t(93) = 0.28, p = .780. The effect sizes were very small for both Mathematics Achievement, Cohen's d = 0.03, and Self-Study Skills, Cohen's d = 0.06.

This indicates that the two groups were statistically comparable before the intervention. Therefore, any posttest differences observed after the intervention can more reasonably be attributed to the instructional treatment rather than initial group differences.

Hypothesis 1: There is no significant difference in pretest and post-test mathematics achievement scores of students taught mathematics using blended learning models and those taught using traditional methods, after controlling for pre-test scores.

The post-test score of the students were compared using the pre-test as covariate.

Table 3: *ANCOVA Summary for Posttest Mathematics Achievement by Instructional Group*

Source	SS	Df	MS	F	P	Partial η^2
Pretest (covariate)	14,567.20	1	14,567.20	178.34	< .001	.660
Group (treatment)	8,924.10	1	8,924.10	112.45	< .001	.550
Error	7,301.80	92	79.40	—	—	—
Total	30,893.10	94	—	—	—	—

The ANCOVA result in Table 3 indicated that there was a significant treatment effect, F(1, 92) = 112.45, p < .001, partial η^2 = .550. The significant effect of the pretest covariate, F(1, 92) = 178.34, p < .001, partial η^2 = .660 suggests students' prior achievement was strongly related to posttest. Nonetheless, after controlling for pretest scores, group membership continued to be a significant predictor of mathematics achievement. As a result, we rejected the null hypothesis.

Hypothesis 2: There is no significant difference in pretest and posttest self-study skills scores of students in the experimental and control groups.

The difference in self-study skill improvement of the different groups was tested for significance using analysis of covariance. The result of the analysis is as shown in Table 3.

Table 4: *ANCOVA Summary for Self-Study Skills by Instructional Group*

Source	SS	Df	MS	F	P	Partial η^2
Pretest (covariate)	28.45	1	28.45	112.67	< .001	.551
Group (treatment)	17.82	1	17.82	68.32	< .001	.426
Error	24.01	92	0.26	—	—	—
Total	70.28	94	—	—	—	—

The ANCOVA result showed that pretest Self-Study Skills was a significant covariate, $F(1, 92) = 112.67$, $p < .001$, partial $\eta^2 = .551$. This implies that students' initial level of self-study skills significantly influenced their posttest self-study skills scores.

After adjusting for pretest Self-Study Skills, the effect of group was statistically significant, $F(1, 92) = 68.32$, $p < .001$, partial $\eta^2 = .426$. This indicates that students exposed to the blended learning model demonstrated significantly higher self-study skills than those taught through conventional classroom instruction. The effect size was large, showing that the treatment made a meaningful contribution to the development of students' self-directed learning behaviours. Therefore, the null hypothesis stating that there is no significant difference in pretest and posttest self-study skills scores of students in the experimental and control groups was rejected.

Discussion of Finding

The findings of this study indicate that the rotation-based blended learning model produced substantial improvement in students' mathematics achievement and self-study skills when compared with conventional classroom instruction. This conclusion is supported by the convergence between the descriptive results and the inferential results: the experimental group recorded higher mean gains, while the ANCOVA results confirmed statistically significant treatment effects after controlling for pretest scores. Thus, the observed improvement cannot be explained merely by initial differences between the groups; rather, it suggests that the instructional model made a meaningful contribution to students' learning outcomes.

The positive effect of blended learning on mathematics achievement is consistent with the wider literature on blended and hybrid learning. Hrastinski (2019) argues that blended learning should not be reduced to the simple addition of technology to classroom teaching, but should be understood as a deliberate integration of online and face-to-face experiences. The present finding supports this position because the intervention did not replace the teacher; rather, it reorganized learning so that students could benefit from teacher explanation, guided classroom support, digital practice, and independent revision. This may explain why students in the experimental group achieved higher posttest scores than those exposed to conventional instruction alone.

The result also agrees with Tong et al. (2022), who found that a flex model of blended learning improved students' mathematics achievement, self-study skills, and learning attitudes. The similarity between Tong et al.'s findings and the present study may be due to the shared emphasis on structured digital engagement, teacher support, and opportunities for students to revisit learning materials outside the normal pace of classroom teaching. In both studies, blended learning appears to have worked not because technology was present, but because technology expanded opportunities for practice, feedback, and learner control.

The findings further corroborate Egara and Mosimege (2024), who reported that secondary school students taught mathematics through blended learning achieved and retained better than those taught through conventional methods. Their Nigerian secondary school context makes the comparison especially relevant. The consistency between their findings and the present study suggests that blended learning can be effective in mathematics classrooms within developing educational contexts when the model is structured, curriculum-aligned, and supported by teacher mediation. However, this agreement should be interpreted carefully. Egara and Mosimege's intervention lasted four weeks, while the present study used a longer intervention period; therefore, the larger gains in the present study may partly reflect greater exposure time, repeated practice, and stronger consolidation of mathematical concepts.

At the meta-analytic level, the result is also consistent with Vo et al. (2017), who found

that blended learning had a positive effect on students' academic performance, particularly in STEM-related disciplines. Similarly, Setiawan et al. (2022) reported a positive effect of blended learning on students' mathematical ability. However, the magnitude of improvement in the present study appears stronger than the average effects reported in some meta-analyses. This difference may be explained by contextual and methodological factors, including the relatively focused subject area, the use of intact classes, the close alignment between intervention activities and the achievement test, and the possibility that students in the experimental group received more frequent opportunities for guided practice and corrective feedback.

Nevertheless, not all previous studies have reported strong or uniform effects of blended learning. Some studies have found mixed or non-significant differences between bl ended and traditional learning environments, especially where students were already high-achieving or where the online component was largely self-paced with limited teacher scaffolding. Balentyne and Varga (2017), for example, noted that evidence on blended learning has been mixed and that some high-ability mathematics students did not show significant achievement differences between traditional and self-paced blended courses. This contradiction may be due to ceiling effects among high-performing students, weaker dependence on teacher-mediated support, or insufficient differentiation between the blended and conventional learning conditions. In contrast, the present study appears to have provided a more structured rotation model, which may have benefited students who needed repeated exposure, feedback, and guided independent practice.

The study also found significant improvement in self-study skills of the students. Blended learning requires students to manage learning time, revisit instructional materials, complete tasks independently, and monitor their progress. The significant improvement recorded by the experimental group therefore suggests that the intervention did not only improve mathematics achievement but also strengthened students' capacity for self-regulated learning. This agrees with Uz and Uzun (2018), who found that blended learning environments can enhance self-regulated and self-directed learning skills. It also aligns with recent evidence from Zhao et al. (2025), who found that self-regulated learning strategies such as organization, metacognition, time management, and effort regulation were significantly associated with academic performance in online and blended learning environments.

The connection between self-study skills and achievement is particularly important. The gain in mathematics achievement may not have resulted from exposure to digital content alone; rather, it may have been mediated by students' improved ability to study independently, practise repeatedly, monitor errors, and seek clarification when needed. This interpretation is supported by Guntur and Purnomo's (2024) meta-analysis, which found that self-regulated learning interventions had a moderate positive effect on learning outcomes in online and blended environments. Thus, the present study suggests that blended learning may be most effective when it simultaneously improves content mastery and the learning behaviours that support mastery.

The findings also have practical implications for mathematics teaching. The evidence suggests that blended learning should be treated as a pedagogical model rather than a technology project. The Education Endowment Foundation (2019) cautions that digital technology is more likely to improve learning when it enhances teaching quality, feedback, practice, and assessment. This is relevant to the present study because the rotation model appears to have created additional opportunities for explanation, practice, and remediation. Therefore, mathematics teachers should not adopt digital tools merely because they are available; they should select tools that support mathematical reasoning, worked examples, diagnosis of errors, feedback, and repeated problem-solving.

However, the positive findings should not be generalized without attention to equity and implementation conditions. UNESCO's 2023

Global Education Monitoring Report warns that although technology can expand learning opportunities, unequal access to devices, connectivity, and home learning support can deepen existing educational inequalities. In resource-constrained settings, blended learning may produce weaker or contradictory results if students lack access to devices, internet connectivity, electricity, or quiet study spaces. This may explain why some studies report smaller or inconsistent effects: the success of blended learning depends not only on instructional design but also on infrastructure, teacher readiness, learner support, and equitable access.

Overall, the findings of this study contribute to the growing evidence that blended learning can improve mathematics achievement and self-study skills when it is structured, teacher-supported, and aligned with curriculum objectives. The study also helps explain why contradictory findings exist in the literature. Blended learning tends to produce stronger effects where online and face-to-face components are meaningfully integrated, where students receive feedback and guidance, where the intervention lasts long enough for learning routines to develop, and where access barriers are minimized. Conversely, weaker or non-significant effects are more likely when blended learning is poorly structured, treated as independent self-paced learning, implemented with limited teacher support, or introduced in contexts where students do not have reliable access to digital learning resources.

Implications from the Findings.

Based on the findings of this study, it could be implied that the teacher may use blended learning as an effective instructional model for improving the learning outcome in mathematics in secondary schools. The rotation hybrid is especially useful because it allows students to alternate among teacher-led instruction, guided group work, and individualized practice with digital tools. A differentiated learning, immediacy of feedback, and opportunities for repeated practice-all features prized in math instruction-are supported by this structure.

The analysis also suggests that the blended learning process should be regarded as a pedagogic model and not a technology project. According to the Education Endowment Foundation (2019) digital technology is likely to improve learning when it improves the quality of teaching, feedback, practice, and assessment rather than when it replaces effective teaching. math teachers must strive to select digital tools that foster mathematical explanation, practice, diagnosis, and feedback rather than just available technologies.

Moreover, the robust improvement in self-study skills indicates that blended learning can effectively support the adoption of independent study habits among students, as long as the model is controlled and monitored. Blended mathematics offerings should therefore explicitly include teacher support for self-study and study routines, including goal-setting, tracking progress, taking reflective notes, timing study sessions, for example, and teacher feedback on independent work. Students may apply self-study skills outside the mathematics classroom and lesson.

The results are also essential for equity and implementation. UNESCO (2023) warned that education technology should be judged based on relevance, equity, scalability, sustainability. In resource-constrained settings, blended learning must not presume that all learners have consistent internet access, devices, and quiet home study spaces. To overcome barriers to equity, schools should offer supervised rotation stations, offline resources, device-sharing plans and teacher-mediated access to online resources. In absence of these supports, blended learning could exacerbate rather than mitigate learning inequalities.

Conclusion

This study examined the effect of a rotation-based blended learning model on mathematics achievement and self-study skills among secondary school students in Ekiti State, Nigeria. The findings showed that students exposed to the blended learning model achieved significantly higher posttest

mathematics scores and stronger self-study skills than students taught through conventional classroom instruction, after controlling for pretest scores. The results suggest that a structured blended learning approach can support both mathematical understanding and independent learning habits when it combines digital practice, teacher guidance, feedback, and monitored self-paced learning.

The study recommends the following;

1. that mathematics teachers and school administrators consider carefully planned blended learning models as part of efforts to improve secondary school mathematics instruction.
2. Implementation should be supported by teacher training, accessible digital resources, reliable classroom routines, and explicit attention to students' self-study skills.
3. Policymakers and curriculum planners should also consider how school-supported rotation models can be adapted for resource-constrained settings without widening digital inequalities.

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PHYSICAL AND HEALTH EDUCATION: PATHWAY TO SOCIO-PEACE STABILITY AT TERTIARY INSTITUTIONS IN NIGERIA

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ABSTRACT

Descriptive survey research was used. The population comprised Physical and Health Education Lecturers in public tertiary institutions in Nigeria. The sample size was Ninety (90), through simple random sampling technique. Fifteen (15) respondents were selected from the first established University in six geo-political regions in the country, Nigeria. Two research questions were raised to guide the study. Data were obtained through a self-designed instrument titled: "Questionnaire on Physical and Health Education: Pathway to Socio- peace Stability at Tertiary Institutions in Nigeria (QPHEPSSTN)". It was fashioned on four point Likert scale format; Strongly Agreed (SA), Agreed (A), Disagreed (D), and Strongly Disagreed, rated on 4, 3, 2 and 1. The research instruments were validated by two experts in Measurement and Evaluation, while its consistency was determined through test-rest method with correlation co-efficient of 0.70. Data were analyzed using, descriptive statistics. Based on the results of the research, conclusions were made that, PHE could maintain and sustain social cohesion, as well as, build positive social skills at tertiary institutions in Nigeria .Based on the conclusions, recommendations were therefore, made that government and managements of tertiary institutions in Nigeria should implement PHE programme. Also made available good facilities for the programme.

Keywords: Physical, Health education, Pathway, Socio-peace, Stability

Introduction

Ability to manage and sustain socio-peace is a major challenge which the managements of educational institutions, specifically, at tertiary level (Colleges of Education, Polytechnics and Universities) have been contending contending with over the years in Nigeria. The state of socio-peace stability in educational institutions is a precarious one, and often marked and characterized with challenges like; religious differences, cultism, ethnic differences, riots, protests, and so on. The breakdown of socio-peace makes educational institutions very unfriendly for acquisition of desirable values, skills and knowledge which individuals needs for overall development of the nation. This has been an ugly and unsavory trend for many decades in Nigeria during the military and civilian era, alike .Socio-peace breakdown had claimed many lives while, property were also, destroyed. Several reasons have been adduced to this situation at tertiary institutions in Nigeria.

Oyekan,(2004) stated that poor management, leadership, poor condition of the school, lack of commitment to students' plights, gap in communication between students and management, hardship and other factors are often exacerbating socio-peace breakdown at tertiary institutions in Nigeria. Thus, throwing at times tertiary institutions to confusion, panic, negative psychologically induced, environment.

Okediji (2015) stated that peaceful co-existence is necessary for the preservation of the centrality and integrity of the society's common interest. Ditto, to human organizations. Peace is not just a human

mind which is personal but also, that which could be interpersonal, inter communal, inter regional, and global (Odia, 2014). At any educational institution, be it primary, secondary and tertiary, if there is no peace to achieve the lofty set- goals, mission and vision statements of such educational institutions may be a mirage, and impossible. Effective teachings and learning take place in an environment devoid and freed of conflict (Oyekan, 2004).

The principle of unity of purpose and action will duly gained ground and thrive where peace is allowed to reign. In Nigerian universities lack of peace has been a primordial issue. It is the responsibility of the management of schools to mobilize and harness the available resources within the school system to guarantee and promote socio-peace. Longman Dictionary of Contemporary English describes peace as a combination of the followings; A condition where there is no war, violence or hostility, a state of freedom from disorder within a country, a state of agreement of friendliness among people living or working together, calmness, quietness, freedom from anxiety or troubling minds, general security of life and property. However, in recent time, government and the management of educational institutions in Nigeria animalist the rising occurrence and incidence of security challenges and breakdown of peace stability have come up with copies strategies will the ugly situation and scenario in bud.

Literature Review

According to Agazuma and Solomon (2021) the level of insecurity in Nigeria has become a social problem, and a hydra-waded monster that cannot be over emphasized because of its far-reaching implications and direct consequences on education, the economy and society in general most of worrisome is the emerging new forms of insecurity challenges in contemporary Nigeria which have taking a disturbing dimension to the extent that it has almost crippled the various sectors, especially the educational sector in Nigeria.

Lehr (2014) stated that the noble goals of education can never be achieved without conducive and peaceful atmosphere. This bore down to the fact that, quality education cannot be achieved in a condition characterized by insecurity, thuggery and violence. In Nigeria, as at today, one of the pro-active strategies and approaches to guarantee socio-peace stability at tertiary level of education the incorporation, fusion and merging of Physical and Health Education with programme or courses of study. Physical and Health Education PHE is a programme that combines the study of education with the science of human movement health renovation. PHE aims to produce qualified professionals like teachers, sports, exercise, physiology, and health education. "A sound mind is a sound body in a sound environment". Every person must possess a health mind to have a health mind one must have a health physique .Healthy persons could only make a health society (Bwarathidasam University nd). It can also be sub-summed that the following are benefits of Physical Education, specifically; development of organic fitness, development of mental health, social development Development of muscular co-coordination, desirable habits, personality, mental hygiene functional knowledge and qualities of good citizenship. Beyond these, Physical and Health Education has been included among extra- curricular activities in Nigerian schools for diverse reasons. Apart from the academic values of PHE it also has extra-curricular benefits to students and academic institutions at large. PHE engages students and interests thus, taking away times some of them would have be devoting on crimes and unethical behaviours.

The researchers observed, that PHE programme has been a good source of carrying or researches by the academics. However, from the extant studies and researches much attention and focus had not been on Physical and Health Education as pathway to socio- peace stability in tertiary institutions in Nigeria. Also, observed was that most of the past studies had been self-reported by researchers without empirical investigation and validation. The above identified gaps were factors that motivated the researchers to carry out this present study.

Lack of socio-peace stability due, to several reasons has been an issue and challenge confronting all the sectors of the nation, Nigeria, educational sector, inclusively. The challenges have made Nigerian schools, especially, tertiary institutions to be unsafe environment for acquisition of desirable skills, values and knowledge which individuals need for national development. The challenges have made the managements of tertiary institutions to devise several copings strategies to ameliorate the situation of which Physical and Health Education was incorporated with the existing extra-curricular activities.

The researchers therefore carried out this study on Physical and Health Education (PHE)

to determine its impact on socio- peace stability at tertiary institutions in Nigeria.

The general objective of the study was on Physical and Health Education (PHE) as pathway to socio- peace stability at tertiary institutions in Nigeria. The specific objectives were to:

1. determine the impact of Physical and Health Education (PHE) on social cohesion at tertiary institutions in Nigeria; and
2. investigate on influence of Physical and Health Education (PHE) on building positive social skills in tertiary institutions in Nigeria.

Two research questions were raised to guide the conduct of the study.

1. Can physical and health education (PHE) sustain social cohesion in tertiary institutions in Nigeria?
2. Does Physical and Health Education has influence on building positive social skills at tertiary institutions in Nigeria?

Methodology

Descriptive survey research design was adopted for the study. The population of the study comprised, Lecturers in the Departments of Physical and Health education in tertiary institutions in Nigeria. The sample size of the study was Ninety (90) respondents that were selected, through a simple random sampling technique from the first established university across the six geo _ political regions in Nigeria

1. University of Ibadan (South West) 1948
2. University of Nigeria Nsukka (South East) 1960
3. Ahmadu bello University, Zaria (North West) 1960
4. University of Benin (South South) 1970
5. University of Maidus (North East) 1975
6. University of Jos (North Central) 1970

Fifteen (15) respondents were selected from each of the six (6) universities to constitute the sample size 90 (Ninety).

Two research questions were raised to guide the conduct of the study data were generated through a self-structured and developed research instruments, titled," Questionnaire on Physical and Health Education : Pathway to Socio-peace Stability at Tertiary Institutions in Nigeria (QPHEPSSTIN), four point likert scale was used; Strongly Agreed (SA) ,Agreed(A), Disagreed (D) and Strongly Disagreed(SD).

The research instruments were validated by two experts in Measurement and Evaluation, while its reliability was determined through, test detest method at two weeks interval, and 0.70 coefficient reliability was obtained. Descriptive statistics (simple percentages, frequency counts and mean (x) was used to analyze data generated for the study

Results and Discussion Of Findings

Research Question: Can PHE sustain social cohesion at tertiary institutions in Nigeria?

Tables 1: Showing simple percentages, frequency counts and mean (ẍ) on can PHE sustain social cohesion at tertiary institutions in Nigeria

N= 90 **C= 2.5**

S/N	ITEMS	SA %	A %	D %	SD %	N	MEAN (ẍ)	DECISIONS
1	Can PHE promote solidarity among students	69 76.66	11 12.22	4 4.44	6 6.66	90	**3.58**	**Agreed**
2	Students solidarity can't be guarantee through PHE	3 3.33	7 7.77	13 14.44	67 74.44	90	**1.4**	**Disagreed**
3	PHE can promote social inclusion in the institution	66 73.33	13 14.44	9 10	2 2.22	90	**3.58**	**Agreed**
4	Social inclusion can't be promoted through PHE in the institution	3 3.33	1 1.11	9 10	77 85.55	90	**1.22**	**Disagreed**
5	PHE can foster peaceful co-existence among the students	59 65.55	11 12.22	9 10	11 12.22	90	**3.31**	**Agreed**
6	PHE cannot foster peaceful co-existence among the students	3 3.33	12 13.33	16 17.77	59 65.55	90	**1.54**	**Disagreed**
7	PHE can sustain mutual respect and understanding among students	64 71.11	16 17.77	9 10	1 1.11	90	**3.58**	**Agreed**
8	PHE cannot sustain mutual respect and understanding among students.	6 6.66	14 15.55	19 21.11	51 56.66	90	**1.77**	**Disagreed**
	TOTAL WEIGHT	273 37.91	85 11.80	88 12.22	274 38.05		**2.50**	**Disagreed**

Source: Field Survey, 2025.

Keys:

N = Total Number of Respondents, **C =** Cut-off-Points, **SA** = Strongly Agreed, **A** = Agreed, **D** = Disagreed, **SD** = Strongly Disagreed.

Table 1 present the finding on research question one. On item (1), responses got were, 69(76.66), 11(12.22), 4(4.44) and 6(6.66) for strongly agreed, disagreed and strongly disagreed respectively. On item (2), 3(3.33), 7(7.77) , 13(14.44) and 67(64.44) were got for strongly agreed, disagreed and strongly disagreed. On item (3), the following responses were obtained, 66(73 .33), 13 (14.44), 9(10) and (2.22) for strongly agreed disagreed and strongly disagreed. on item (4), 3(3.33) , 1(1.11), 9(10) and 77(85.55) responses were obtained for strongly agreed, agreed, disagreed and strongly disagreed also on item (5) responses obtained indicated, 59(65.55), 11(12.22), 9(10) and 11(12.22) for strongly agreed, agreed, disagreed and strongly disagreed, as well on item (6) the following responses were got ,3(3.33) ,12(13.33) ,16(17.77) and 59(65.55) for strongly agreed, agreed,disagreed and strongly disagreed. On item (7) responses got were , 64 (17.11) 16 (17.77) , 9 (10) and 1(1.11) for strongly respectively .On item (8) responses got should , 6(6.66) , 14(15.55) ,19(21.11) and 51(56.66) for strongly agreed , agreed , disagreed and strongly disagreed .

Generally speaking, the total weight of the findings indicated that the average rating scale of four (ẍ=2.5) was not lessen than the mean (ẍ) of average ratings scale of four (ẍ=2.5) the result .Therefore, portends that physical and health education (PHE) could sustain and maintain social cohesion in Nigerian Universities.

Research Question Two: Does PHE has influence on building positive social skills at tertiary institutions in Nigeria?

Tables 2: Showing simple percentages, frequency counts and mean (ẍ) on does PHE has influence on building positive social skills in at tertiary institutions in Nigeria.

N= 90 **C= 2.5**

S/N	ITEMS	SA %	A %	D %	SD %	N	MEAN (ẍ)	DECISIONS
9	Does participating in PHE activities promote interaction among student	69 76.66	11 12.22	9 10	1 1.11	90	**3.64**	**Agreed**
10	PHE does not was a strong influence on promoting interaction among student	6 6.66	4 4.44	19 21.11	61 67.77	90	**1.5**	**Disagreed**
11	Through PHE conflicts among students can be resolved	63 70	13 14.44	9 10	5 5.55	90	**3.48**	**Agreed**
12	Through PHE conflicts among students cannot be resolved	9 10	2 2.22	13 14.44	66 73.33	90	**1.48**	**Disagreed**
13	PHE can build strong relationships among students	62 68.88	13 14.44	6 6.66	9 10	90	**3.42**	**Agreed**
14	PHE was in impact in building strong relationship among students	2 2.22	12 13.33	13 14.44	63 70	90	**1.57**	**Disagreed**
15	PHE enhances cooperation and teamwork among students	66 73.33	14 15.55	8 8.88	2 2.22	90	**3.6**	**Agreed**
16	PHE has no position influence on enhancement of cooperation and teamwork among student	3 3.33	9 10	16 17.77	62 68.88	90	**1.47**	**Disagreed**
	TOTAL WEIGHT	280 38.88	78 10.83	93 12.91	269 37.36		**2.52**	**Agreed**

Source: Field Survey, 2025

Keys:

N = Total Number of Respondents, **C** = Cut-off-Points, ẍ= Mean, **SA** = Strongly Agreed, **A** = Agreed, **D** = Disagreed, **SD** = Strongly Disagreed

Tables 2 presents the findings on research question two as follows: On item (9), responses obtained showed, 69 (76.66), 11 (12.22), 9 (10), and 1 (1.11) for strongly agreed, agreed, disagreed and strongly disagreed. On item (10), the following responses were got also; 6 (6.66), 4 (4.44), 19 (21.11) and 61(67.77). On item (11) responses obtained showed 63 (70), 13 (14.44), 9 (10) and 5 (5.55) for strongly agreed, agreed, disagreed and strongly disagreed. On item (12), the followings responses were obtained; 9 (10), 2 (2.22), 13 (14.44) and 66 (73.33) for strongly agreed, agreed, disagreed and strongly disagreed, respectively. On item (13) responses got showed, 62 (68.88), 13 (14.44), 6 (6.66) and 9(10) for strongly agreed, agreed, disagreed and strongly disagreed, also, on item (14), responses got

were, 2 (2.22), 12 (13.33), 13 (14.44) and 63 (70) for strongly agreed, agreed, disagreed and strongly disagreed, as well on item (15), responses got were, 66 (73.33), 14 (15.55), 8 (8.88) and 2 (2.22), for strongly agreed, agreed, disagreed and strongly disagreed, respectively. On item (16), responses got were 3 (3.33), 9 (10), 16 (17.77) and 62 (68.88) for strongly agreed, agreed, disagreed and strongly agreed.

However, the total weight of the findings revealed that the average rating scale of four (ẍ = 2.5) was lesser than the mean (ẍ) of average rating scale of four (ẍ = 2.52), thus, indicated that Physical and Health Education could build positive social skills among students tertiary institutions in Nigeria.

Discussion of Results

The results on research question one indicated that Physical and Health Education (PHE) could sustain and maintain social cohesion at tertiary institutions in Nigeria. This result aligns with the view of Adetunji, Silva, Tulsiani and Adeniran (2023) that connectedness, solidarity and trust through sporting activities could be achieved. Further, those sports could encourage positive social interaction and foster unity. Also apart from the psycho-social benefits of PHE to students, sporting activities can easily channel minds and energies of students away from re-furious activities that can truncate peaceful atmosphere and affect schools' climate negatively.

The results on research question two also, indicated that through, Physical and Health Education positive social skills could be positively build in at tertiary institutions in Nigeria. The result was corroborated by the submission of Oyekan (2004), that one of the benefits of PHE is that it provides a practical environment for warning and practical teamwork, cooperation, communication and sportsmanship. Through team sports and group activities, students learn to work together, resolve conflicts, and develop empathy, respect and leadership abilities.

By and large, PHE programme offers many advantages to students and management of Nigerian Universities by engaging, specifically in sporting activities this thus, enhance peaceful co-existence, interaction and development of solidarity.

Conclusion

Based on the results of the study conclusions were made that Physical and Health Education (PHE) could maintain and sustain social cohesion as well as, build positive social skills at tertiary institutions in Nigeria.

Recommendations

Based on the conclusions the followings recommendations were made;

1. The management of tertiary institutions in should mobilize enough and adequate resources for a proper implementation Physical and Health Education programme.
2. Since PHE could sustain pecile, it should be made a compulsory course for all students in respect of their courses.
3. Physical and Health Education programme should be prioritized by the management of tertiary institutions in Nigeria.
4. There should be a proper monitoring and supervision of the implementation of PHE programme at tertiary institutions in Nigeria.
5. Students should be encouraged to develop interest on PHE programme due, to its benefits socially, mentally,, physical development, and so on.
6. The appropriate facilities should be made available for PHE programme management and implementation at tertiary institutions in Nigeria.
7. Government sub-ventures should be timely made available for PHE programme by governments and other provider of tertiary education in Nigeria, and so on.

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SOCIO-ECONOMIC STRUCTURE OF NIGERIA: CHALLENGES AND OPPORTUNITIES FOR NATIONAL DEVELOPMENT

BY

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Abstract
This study examined Nigeria's socio-economic structure with a view to describing the organisation of society in terms of economic activities, types and patterns of trade, indigenisation, privatisation of the Nigerian economy, and the roles of multinational companies in improving citizens' quality of life. It is an indisputable fact that education contributes immensely to the nation's growth and development through effective teaching strategies and research, thereby improving individuals' knowledge, skills, and productivity, which, in turn, enhances national development. The method adopted was historical and descriptive in explaining the key structures of the economy that contributed to economic growth and development. The paper delineated the challenges and opportunities of the socio-economic structure and identified areas where solutions should be implemented to achieve effective national growth and development. A conclusion was drawn by analysing effective strategies that can assist Nigeria's socio-economic structure, such as promoting industry, diversifying the economy, eradicating corrupt practices, investing in education and skills development, and providing social amenities and rural development. The study therefore recommended that the government ensure economic diversification, provide employment opportunities for all citizens, provide social amenities, invest in education, eradicate corrupt practices, and undertake other measures to make society a good place to live.

KEYWORDS: *Socio–Economic Structure, Nigeria, Challenges, Opportunities, National Development.*

Introduction
A country like Nigeria, concerned with national development, seeks to improve the quality of life for all its citizens. In part, this involves solving the problems of the various institutions that make up society. These problems include social, economic, religious, political, and other environmental problems that hinder the development and progress of people.

The entire social system is composed of many units; each act both independently and collectively to sustain the superstructure commonly referred to as the social system in any given dynamic society. The Nigerian economy has undergone structural changes and growth from the pre-colonial period. Despite the rapid growth of the country's economy in recent years, the country is still developing. This study is therefore designed to discuss the socio-economic structure of Nigeria from the pre-colonial era to date, highlighting the challenges and opportunities of survival in relation to marketing systems and organisations, prices, privatisation, and the indigenisation of the economy.

The Structure of Nigeria's Economy
The structure of any system is a great determinant of its growing tendencies. The growth of the economy is conventionally and conveniently measured using the indices of Gross National Product (GNP) and Gross Domestic Product (GDP). To better understand the Nigerian Economy, the various sectors will be examined. According to Gbadebo (2025), the six phases of economic development in the country consisted of the pre-colonial era, the colonial era, and the immediate post-independence era., the structural adjustment era and the oil boom era.

The pre-colonial period was characterized with local people with different languages occupying the area now knowns as Nigeria, as noted by Okafor (2024). During this period, Nigeria had not yet emerged as a unified political entity, nor was there a centralized system of government, Instead the era was characterized by the pursuit of survival by different ethnic groups, often expressed through inter-tribal conflicts and wars. Production was carried out with crude implements; farming, hunting, and blacksmithing were the main occupations. The production carried out was for self-sustenance, and later developed into a trade called barter. There were no established markets except Kano which served as the only commercial centre for the tran-sahara trade in the north around A.D.1000. The

report noted that production was generally low along market routes like Ilaro, Eruwa, Ogbomosho and Ketu which resulted in low standard of living, Foreign trade was largely limited to North Africa and this resulted to predominance of primary production and the non-existence of modern manufacturing activities except for few local crafts (Adua, Olusola and Ogbonna, 2025).

The marketing system and organisation in the pre-colonial era were largely conservative. People relied heavily on what their immediate environments could offer. They organised themselves and appointed local chiefs and elders to run the affairs of their various societies. An increase in population led people to look for things not found in their immediate environments, which, in turn, led to the exchange of goods for goods and services for services, called bartering. Barter, by definition, means exchanging goods that are not available in an environment with whatever goods or services are needed from another environment.

According to Igechi (2025), the barter system is cumbersome and difficult to make deferred payments. Some of the characteristics of the barter system include: no standardised measures of value, goods cannot be stored, no market specialisation, exchange of goods depends on coincidence, and some goods cannot be divided for exchange. Akanmike, Okonkwo, and Ejioku (2024) noted that the movement of traders was restricted because markets were established outside inhabited areas. In pre-colonial Yorubaland, women were prominent in trading activities. During the period of inter-tribal warfare, it was relatively safer for women to move between communities and engage in trade (Gimba, 2012). Organised institutions such as banking, advertising and insurance were absent. Insecurity made it difficult for people to store goods for long periods, and commercial activities were then limited to domestic trade. Abiodun, Magaji, and Ismail (2025) noted that the colonial era was enabled by Europeans' voyages to the African continent, culminating in the British establishment of political control over Nigeria in 1851. Trade was the major factor which aroused the interest of the colonialist. Their major interests were the provision of raw materials for British industries and the provision of employment for their agents. This development encouraged raw materials production. The scope and density of agriculture, which was the mainstay of the economy, were widened. Crops such as cocoa and kola nut were introduced from South America and the West Indices. In the western zone, trade routes linked Lagos, Ibadan, and Ilorin, as well as Ilaro and Ogbomosho. Through these routes, European products were exchanged with the local ones. In the Eastern zone, people from Aro-Chukwu, riverine and coastal people from Calabar, Degema, and Opobo traded directly with the European ships. Obstacles to commercial activities during the period include banditry and terrorism, poor transportation and communication networks, the absence of banking services, and sundry financial problems.

The immediate post-independence era between 1960 and 1962 marked slight changes in the structural transformation of the Nigerian economy, (Adeyemi et al.2025). There was a notable transformation in the manufacturing sector. The new breed of politicians saw this period as an opportunity to develop the country, leading to the provision of new infrastructure and improvements to existing infrastructure. The period between 1962 and 1965 saw one crisis after another, but this did not halt development entirely. The rate of growth at this time appeared to be the highest in the country's history, and manufacturing also grew.

The emergency era came early in the life of independent Nigeria. This period marked the beginning of a political crisis which erupted in the West. The 1962 crisis led to the military's intervention in politics, which persisted until 1999, when a civilian administration was inaugurated. The political crisis led to the military takeover of the government and created the conditions that eventually led to Nigerian Civil War, which lasted from 1967 to 1970 (Audu, Osuala, & Ibrahim, 2013). During this period, the oil fields in the Eastern region were closed down, as was the foreign economic sector. The interaction was shaken, which proved that political stability was necessary for economic development. The gross domestic product during this period fell in value. This can be seen from the introductory chapter of the 2nd National Development plan, which states that "Although the economy was managed in such a way as to ensure that projects in progress were completed on schedule, the government could not initiate new schemes, nor could the normal maintenance of existing infrastructures be sustained.

At the end of the civil war in 1970, there was. a process of reconciliation and rehabilitation of the ruined economy, as well as the opening of the oil well. This development launched Nigeria into a new era, generally referred to as the oil boom, during which production astronomically

increased from 0.77 million barrels per day to 2.0 million barrels per day in 1974. Nigeria recorded a balance of payments surplus of 3,102.2 million, the highest ever recorded in the country's history. This situation led to salary increases for workers, the execution of white elephant projects, the hosting of all kinds of festivals, extravagant spending, embezzlement, abuse of office by public officers, and inflation. No effort was made to develop other sectors, such as mining and manufacturing (Smith and Todaro, 2020).

Adeyemi et al. (2024) noted that the oil boom period ushered in economic expansion. This led most Nigerians to import foreign goods, neglecting locally produced ones. The so-called buoyant economy triggered a recession, which in turn led to a decline in the surplus. The economy could no longer be sustained and maintained, which led to initiation of various programs by both the military and civilian governments to relief the economy from total collapse and ease the suffering of the masses, for example, General Obansanjo's National Economic Empowerment and Development (1999 – 2007), Umaru Musa Yar'Adua's Seven – Point Agenda (2007 – 2010), Goodluck Jonathan's Transformation Agenda and Subsidy Reinvestment Programme (SURE) (2010 – 2015), Muhammadu Buhari's Economic Recovery and Growth Plan (ERGP) (2015 -2023) and Bola Ahmed Tinubu's Renewed Hope Agenda (2023 – Date). These programmes were initiated to restructure the nation's economy for the betterment of all citizens.

Type and Patterns of Trade in Nigeria

Trade can be defined as the exchange of commodities and can be categorised into:

Home trade (internal trade) and foreign (external) trade.

Home trade, also called internal trade, is carried on within the country. The division of home trade is retail and wholesale trade. The focus of retail is to make goods available to the final consumer. The retail trade is the final link in the production chain. The functions of the retailer according to Ayodele (2023) include, delivery of goods and services to the final consumer, granting of credit facility of goods to the consumer as a result of his personal business relationship between them, provision of the consumer's wants at the right time, guiding the consumer in the choice of goods and services, being the intermediary between the wholesaler and the final consumer.

Wholesale trade, on the other hand, involves buying goods in large quantities from producers and selling them in smaller quantities to retailers, who then sell them to consumers. Types of wholesalers include those who buy goods in large quantities from producers, store them, and sell to retailers; those who act as agents for manufacturers; wholesalers who are importers and exporters; and those who process goods before they reach the retailer. Foreign trade is external or international trade. It is the trade between two or more countries or between the people of a country and the people of another country. It involves imports, which are visible, e.g., crude oil, electronic appliances, and cocoa, as well as invisible services such as banking and shipping. It also cuts across international boundaries, for example, trade between Nigeria and Japan, the U.S.A., Ghana, and Nigeria, or Nigeria with any other foreign countries. Nigeria exports mainly palm oil and palm kernel from the south-east, cocoa from the south-west, groundnut and cotton from the north.

Gbadebo (2025) cited advantages of foreign trade to include: encouraging local manufacturers to improve the quality of their product, helping Nigerian crude oil to be made available and demanded by many countries in the world, encouraging close economic ties between Nigeria and its neighbouring countries, and raw materials needed in industries are bought from other countries e.g. brewing, textile, manufacturing etc. Nigeria can supplement its food production with imports from other countries. Nigerian products are exported to other countries through foreign trade, and machinery/equipment is imported from abroad for use by local industries. Foreign trade encourages mutual understanding and good relationships among the countries concerned.

Indigenisation and Privatisation of the Nigerian Economy

Indigenisation policy, according to Oyuokerroye (2023), was formulated in the early 1970s by the Nigerian Enterprise Promotion Decree of 1972 and the Nigerian Enterprise Promotion (Amended) Decree of 1974. Before then, foreign companies such as United Africa Company, John Holt, Kingsway, and other private foreign investors dominated the commercial trade entering West African countries, as well as the industrial and service sectors of the economy. Industries such as petrochemicals, paints, soft drinks, brewing, textiles, and milk products, as well as services such as banking, shipping, and insurance, were largely owned by foreign investors. Nigeria's imports include manufactured goods such as automobiles,

electronics, textiles, chemicals, and petroleum products. Many goods that used to be imported are now produced locally, such as textiles, flour, shoes, tobacco, liquor, building materials, and iron sheets. Large European firms such as the United African Company (UAC) acted as import merchants before independence. Now, many Nigerians are taking up the job. These are essential social services and may or may not generate profit; hence, the government has acquired substantial shares in recent years in other enterprises that are purely profit-oriented, such as banks, insurance companies, shipping companies, and oil companies, to control their ownership and operations. These enterprises are expected to generate profit since they are commercial in nature and in operation, but the opposite is true. There is a gross inefficiency in their operations, which has influenced the government's decision to privatise these enterprises. The following are possible causes of non-performance of government parastatals:

(i) The tendency to run or manage government enterprises as government departments.
(ii) Widespread corruption.
(iii) Political corruption.
(iv) Lack of maintenance culture and an " I don't care attitude by Nigerians towards public enterprises.
(v) General negative attitude of Nigerian labour towards governmental jobs.
(vi) The general tendency of Nigerians to enjoy services provided by parastatals free of charge. This free-of-charge syndrome is partly responsible for the non-payment of electricity or water bills by many Nigerians.

Multinational Companies and the National Economy

Multi-national companies are companies owned by two or more different nations. The presence of multinational companies in Nigeria is expected to foster strong international economic relations. Their characteristics include: Joint ownership of enterprises by many different nations (e.g., Texaco, Lever Brothers), large-scale operations (e.g., oil companies, banks), and reliance on advanced technology and a skilled workforce in their operations (e.g., oil companies). Their operations are not restricted to a single state; examples include oil companies such as Texaco and Shell, banks (e.g., Union Bank and United Bank for Africa (UBA)), and trading companies such as Kingsway and John Holt, which are located in many countries.

These companies have establishments in many countries worldwide. Before and after independence, the Nigerian economy was dominated by multinational companies. To increase Nigerians' participation in the economy and the proportion of ownership in industries, commerce, and finance, the federal government in the 1970s embarked on indigenisation exercises.

Despite the indigenisation exercise, the economy remains dominated and controlled by multinational companies due to the following factors:

(a) Historical attachment of the economy to the colonial and British trading companies
(b) National companies rely on the multinational technology companies, e.g. NNPC.
(c) Multinational Companies operate advanced, large-scale technology compared to small-scale enterprises solely operated by Nigerians.
(d) Nigerian partners, mostly retired civil servants and retired soldiers, top politicians and bureaucrats who are made chairpersons, directors and top executives are corrupt. They arrange and obtain kickbacks, which are often paid into their foreign bank accounts.
(e) The foreign partners continue to control and dominate the management of technology and major operations of multinational companies in Nigeria, with Nigerian partners as mere shareholders without much grip on the management of technology and operations of the enterprises. For example, multinational oil companies in Nigeria, including Mobil, Shell, Elf, Agip, and Texaco, still dominate NNPC. The NNPC depends on these multinational countries to operate.
(f) Refusal of foreign partners to transfer technology to Nigerian partners.

Challenges of the socio- economic structure of Nigeria

Nigeria's socio – economic structure is faced with many challenges ranging from environmental factors to human inflicted problems, such as environmental degradation by nature and human activities, leadership problems, corruption, instability in government, unemployment, income inequality, poor infrastructure, poor governance, inadequate funding of educational programs, insecurity, low industrialization, over population and lots of challenges that affect the effective functioning of the economy.

Prospects of the socio-economic structure of Nigeria

Looking at the structure of the Nigerian economy and its attendant problems, it is considered that Nigeria does not exist in isolation from the international community.

Most developed countries of the world have experienced these problems and have gotten solutions to them, which implies that governments at all levels can proffer solutions to these problems if adequate attention is given to the following :

Identify the problem: The most important thing is that countries identify their major problems and solve them. An adage says that when a problem is identified, it is moving towards solutions. The major problem facing our economy is leadership management. The situation of this country rests on the quality of elected leaders. Secondly, structural adjustment program (SAP) and other programs by various governments to revive the economy and ensure equal distribution of resources to all citizens

Also, a complete restructuring of the economy is needed to enable citizens to access good lives and the entitlements enshrined in the constitution.

The government's current rural development policy is a step in the right direction. The government should implement local government autonomy to allow rural areas to enjoy the dividends of democracy through the local government chairpersons, who should be properly monitored. When rural areas are developed, the spate of rural-urban drift will be controlled.

The present directorate of employment scheme is another step in the right direction towards good restructuring of the Nigerian economy. Considering the global nature of the problem, one can conclude that there are greater prospects for socio-economic survival in Nigeria. We need to contribute our quota to the country's economic survival, not fold our arms and watch what the government does to its citizens.

Conclusion

The Socio-Economic structure of Nigeria from the precolonial era to date has recorded a dramatic success. The Prospects recorded so far indicate that the Nigerian economy will continue to develop, provided leaders work in unity to ensure rapid development at all levels. Nigeria has abundant natural and human resources that can boost the country's economy, provided all stakeholders work effectively and efficiently to advance its growth and development.

Recommendations

- Federal government should ensure economic diversification.
- Employment opportunities should cut across all citizens.
- Social amenities like, good roads, good drinking water, good hospitals, good schools and other facilities should be made available for all citizens.
- Government should invest in education.
- There should be eradication of corrupt practices, and undertake other measures to make society a good place to live.

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