HAUENSTEIN PSYCHOMOTOR MODEL AND TECHNICAL COLLEGES STUDENTS LEARNING INTEREST IN DOMESTIC INSTALLATION IN BAUCHI STATE

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Abstract

The study examined Hauenstein psychomotor model and technical college students learning interest in Domestic Installation in Bauchi state. To achieve this, two specific objectives, two research questions and two corresponding null hypotheses guided the study. Quasi-experimental design was employed as the design of the study; specifically pre-test post-test nonequivalent treatment group design was used. The population of the study comprised 318 NTC II technical colleges' students that offered Domestic Installation in the state. A purposive sampling technique was used in selecting two out of the eight technical colleges offering Domestic Installation to come up with a sampling frame of 79 students as intact classes for both experimental and control groups. The research instrument captioned Domestic Installation Interest Inventory (DIII) was adapted from NABTEB. The data collected for the study were analyzed using mean and standard deviation present in SPSS software while, the null hypotheses were tested using independent samples t-test at 0.05 level of significant. The result revealed that, the learning interest of students taught using Hauenstein psychomotor model outperformed students taught using conventional approach. Based on the findings of this study, it was concluded that Hauenstein psychomotor model improved students learning interest in Domestic Installation. The study recommended Domestic Installation teachers in Technical Colleges should use Hauenstein psychomotor model in teaching Domestic Installation to enhance student's learning interest.

Keywords: Hauenstein Psychomotor Model, Domestic Installation, Learning Interest, Technical College

Introduction

Technical colleges in Nigeria are the training ground for practical skill acquisition and every sector of the economy requires one form of practical skill or the other to function effectively. Therefore, it is important for teachers at this level to ensure that proper teaching method is employed to make learners (students) achieve the required practical skills and improved their learning interest, especially in Domestic Installation. According to Moses (2017), teaching practical skill in Domestic Installation could help the learner to; achieve a right attitude to work, have a good sense of duty and respect for the dignity of labour. Preparing the learner (students) to be worthwhile in vocational and technical education activities or as business owners, acquire saleable skills needed to improve the production, marketing and exchange of raw materials for man and industries (Adebisi, 2015).

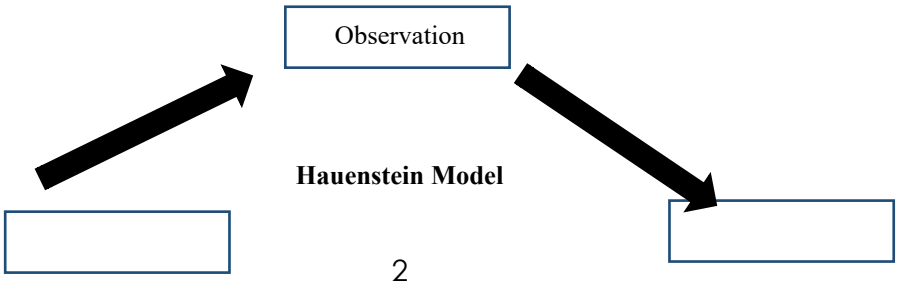
Interest is an educational concept that determines some aspects of students' affective domain which is very important in the teaching and learning process. It also entails willingness to acquire skills, knowledge, attitude, and values. It is the eagerness to learn a set out task or activity for positive and near mastery of the skills and knowledge related to the activity (Unachukwu and Okeke, 2020). This assertion entails that learning Domestic Installation would not be effective without arousing students' learning interest using the appropriate teaching method. Similarly, Okekeokosisi and Okigbo (2021) defined interest as an emotionally oriented behavioral trait that determines a students' urge and vigor to tackle educational programs or other activities. Hence, interest, in the context of this study, may be

defined as a personal attribute of a student towards a learning situation usually expressed as like or dislike. From the above definitions, it can be deduced that interest is an important factor that needs to be considered for effective learning to take place. Supporting the above assertion, Udoh (2019) stated that meaningful learning depends on interest and how motivated learners are during the teaching and learning scenarios as when students feel passionate about lesson content and its method of instruction, the student's interest is aroused, and this fosters achievement and retention.

Domestic Installation as a module (subject), is one of the Technical and Vocational Education and Training (TVET) Programme which provides training that leads to the production of skilled personnel like craftsmen and technicians who could either secure employment at the end of their training, set up their own businesses or further their studies in polytechnics, colleges of education (Technical) and universities (National Board for Technical Education, (NBTE, 2003). Kazeem, (2016) opined that Domestic Installation is that aspect of skills acquisition which utilizes scientific knowledge in the acquisition of practical and applied skills for solving technical problem. Kazeem further maintained that the primary purpose of Domestic Installation is to prepare persons for gainful employment in a recognized occupation. The teaching and learning of DI should furnish students with saleable skills and competencies to enhance their development of self-reliant initiatives. To achieve this objective, effective teaching model with proper sequence of learning like Hauenstein psychomotor model need to be employed by teachers in teaching of Domestic Installation in order to help produce DI graduate who can be self-reliant and thus curbing insecurity in the country by opening up self-employment ventures.

Federal Republic of Nigeria (FRN, 2001) stressed that individuals trained in Domestic Installation in Technical Colleges are expected to acquire practical skills for manufacturing and servicing in industries, power generation, utilization and realization of goals. The realization of such goals in technical colleges in most states in the country including Bauchi state seems to be far below expectation. This may be due to low level of student's exposure in training processes in practical skills in the school workshops, laboratories, inadequacy of books, learning environment, computer rooms, instructors and curriculum content and teaching method (Akhuemonkhan and Raimi, 2016). The problem of inadequate practical skills acquisition in Domestic Installation may be due to improper choice of teaching method used by teachers and thus, causing the expensive venture of opening training schools in many industries where fresh graduates are being trained when employed (Hadroma, 2018). Consequently, graduates shy away from taking up employment where they might be called upon to demonstrate their practical skills acquired. This is due to the fact that the students were not exposed to work-based teaching sequence like Hauenstein psychomotor model during their learning activities in schools and which may be connected to wrong choice of teaching method that can rouse students learning interest and also resulted in ill-quipped graduates of Domestic Installation who have remained unemployed. The teaching method employed by the teacher could be a strong determinant of students' learning interest and academic performance (Emanuel, Irene, & Charles, 2021). With this, Hauenstein psychomotor model is one of the best teaching models that can help DI students achieve high level of learning interest.

Hauenstein (1972) developed a model of psychomotor skills organized on the sequence of learning practical skills to include: Observing; Imitation; Manipulating; Performing and Perfecting. In this model, the sequence of learning skills starts with observing the skill, and then followed by imitating through to perfection. The model is comprehensive enough and it is applicable to technical and vocational training offered at the Secondary School level particularly technical colleges. From the foregoing, it is expected that a well-designed instructional (student-centered) pedagogy like Hauenstein psychomotor model might cater for the complete development of students' learning interest in practical skills acquisition in Domestic Installation. Since one of the most important features of Domestic Installation is its orientation towards the world of work and the emphasis of the curriculum is on the acquisition of employable skills, therefore the psychomotor domain that deals primarily with physical or practical skills development is most emphasized in TVET and that include DI. Therefore, Hauenstein psychomotor model and how suitable they are applied in improving students' learning interest in Domestic Installation in Bauchi State Technical Colleges is the concern of this study.



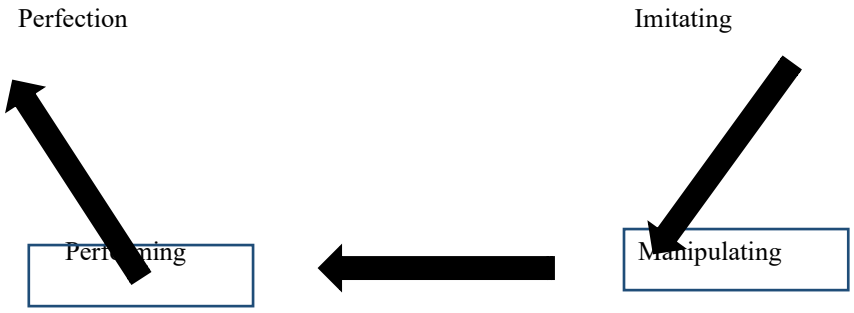


Fig 1: Chart of Hauenstein Psychomotor Model

Statement of the Problem

The high level of unemployment in Bauchi state and Nigeria as a whole requires that educational institutions especially technical colleges should ensure that students acquire relevant knowledge and practical skills in their different fields of learning including Domestic Installation, for them to be gainfully employed on graduation. DI is a skill-based course of study offered in technical colleges and practical skills acquisition is the major distinguishing aspect of technical education which makes it outstanding from liberal arts. Products of the programme are expected to develop psychomotor skills in installing, maintaining and repairing of electrically energized systems such as residential, commercial and industrial buildings and equipment. It is expected on DI teachers to adopt suitable methods for making the teaching and learning process interesting and sufficiently effective, but all these are no longer obtainable on Domestic Installation graduate due to poor teaching method employed by the DI teachers, which make students lose interest in practical skill acquisition and that continue to affect the graduate of DI produced year after year in Bauchi state.

Available records revealed that there has been a persistence poor learning interest of student's in practical skill acquisition in Domestic Installation at Bauchi State technical colleges (NABTEB Chief Examiners Report, 2019-2022). This could be as a result of DI teachers' use of unsuitable teaching methods that would improve students' learning interest in all the components of DI and enable them adequately develop psychomotor skills. Therefore, it is on this background that this study was conducted. This make the study on Hauenstein psychomotor model and technical colleges' student's learning interest in Domestic Installation in Bauchi state to provide empirical data that will enable relevant stakeholders take objective remedial actions.

Research Objectives

The aim of this study was to determine the impact of Hauenstein psychomotor model on technical colleges' student's learning interest in Domestic Installation in Bauchi state. Specifically, the objectives of this study intends to:

1) Compare urban and rural Domestic Installation mean interest scores of student's toward Hauenstein psychomotor Model in technical colleges before the implementation.
2) Compare urban and rural Domestic Installation mean interest scores of student's toward Hauenstein psychomotor Model in technical colleges after the implementation.

Research Questions

The following research questions guided the study:

1) What is the mean difference between the urban and rural Domestic Installation students' interest scores toward Hauenstein psychomotor Model in technical colleges before the implementation?
2) What is the mean difference between the urban and rural Domestic Installation students' interest scores toward Hauenstein psychomotor Model in technical colleges after the implementation?

Hypotheses

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

$H_{01:}$ There is no significant difference between urban and rural Domestic Installation mean interest scores of student's toward Hauenstein psychomotor Model in technical colleges before the implementation.

$H_{02:}$ There is no significant difference between urban and rural Domestic Installation mean interest scores of student's toward Hauenstein psychomotor Model in technical colleges after the implementation.

Relevant Literature Reviewed

The relevant literatures were reviewed under the following seven (7) subheadings; Theoretical Frame Work (Kolb,s Experimental Learning Theory), over view of domestic installation in technical colleges, effectiveness of Hauenstien psychomotor model in teaching and learning, conventional approach used in teaching and learning domestic installation, effectiveness of Hauenstein psychomotor model on students learning interest in domestic installation, Benefir of observation, imitation, manipulation, performing and perfection in learning domestic installation and 10 reviewed of relevant empirical studies. The gap observed is that the impact of Hauenstein Psychomotor Model have not been used to prepare to improve students' learning interest in practical skill acquisition at technical colleges especially in Bauchi state. The study therefore filled the gap by using Hauenstein Psychomotor Model for teaching Domestic Installation students and to study it effect on students learning interest.

Methodology

This section presents the methodology that was used in carrying this study under the following sub-headings: Research Design, Sample and Sampling Technique, Instrument for Data Collection, Method of Data Analysis, and Decision Rule.

Research Design

The study adopted quasi-experimental design. Specifically, the pre-test post-test non-equivalent treatment group design was adopted for the study. According to Nworgu (2015), quasi experimental research design permits the use of intact classes. This design was adopted because it is not possible for the researcher to randomly sample the subjects and assign them to groups without disrupting the academic programme and the timetable of the technical colleges involved in the study. In support of this, Cresswell, 2012 also opined that the design includes assignment, but not random assignment of participants to groups, because the researcher cannot artificially create groups for the experiment.

Sample and Sampling Technique

Purposive sampling technique was used to select two out of the eight technical colleges from three educational inspectorate divisions (Bauchi South Educational Division, Bauchi North Educational Division and Bauchi Central Educational Division). A target population of 79 students (sampling frame) was used for this study. More so, the two technical colleges was chosen because they have their Domestic Installation programme recently accredited by NBTE and NTC II students are chosen because significant portion of the Domestic Installation curriculum content was taught to the students. The two schools selected are Government day technical college Bauchi (GDTCB) as the urban technical college whom were taught using Hauenstein Psychomotor Model and Government day technical college Kafin Madaki (GTCKM) as the rural technical college whom were taught using conventional approach and the sampling frame of 79 students were used as the target population as depicted in the table below:

Table 1: Sample Size for the Study

Name of Schools	Number of Students
Government Day Technical College Kafin Madaki (GDTCKM)	41
Government Day Technical College Bauchi (GDTCB)	38
TOTAL	**79**

Field Survey, 2023

Instrument for Data Collection

The instrument used for collecting data comprised of student's practical response instrument captioned Domestic Installation Interest Inventory (DIII). The DIII was adapted from NABTEB examination practical questions which were generated from the topics that were treated in the experiment.

Domestic Installation Interest Inventory (DIII)

The Domestic Installation Interest Inventory used is a 30 item instrument that was constructed using questions adapted from NABTEB question papers of 2020-2023. Questions 1-10 were adapted from 2020-2021, 11-20 were adapted from 2021-2022 and 21-30 were adapted from 2022-2023 respectively. The marking guide was based on technical college Domestic Installation content for NTC II students. However, the DIII was divided into two sections. Section one covered demographic characteristics (personal data) of the students, while section two covered practical test questions that covered the students use of Hauenstein psychomotor model and how its influence their learning

interest. In addition, section two of the DIII composed of three practical questions of which thirty (30) items were constructed under as marking guide and the rating of the marking guide was based on five point graphic rating scale. The five point graphic rating scale comprised of Exceptionally Good, Above Average, Average, Below Average and Poor. Therefore, the scale were scored as Exceptionally Good = 5point, Above Average = 4point, Average = 3point, Below Average = 2point and Poor = 1point. The practical test items were based on the following specific Domestic Installation topics that were covered in the study: Trunking Wiring of Two Points of Light Controlled by One Way Switch, Surface Wiring of Single Light Point Controlled by a One Way Switch, and Conduit Wiring of Two Points of Light Each Controlled Separately by Two One Way Switches.

Methods of Data Analysis

The research questions for the study were answered using Mean and Standard Deviation. Mean and Standard Deviation has more reliability than other measures of central tendency (Okonkwo, 2014). Moreover, the Null hypotheses H_{01}-H_{02} were tested at 0.05 level of significant using independent sample t-test. Independent t-test was used to compare the mean between the groups (experimental and control groups).The results of both experimental and control groups collected were analyzed using Statistical Package for Social Science (SPSS). This package (SPSS) was used because it provides an efficient and organized way to analyzed, manage large and complex data during statistical analysis.

Decision Rule

A mean score of 3.00 and above was considered accepted and a mean score below 3.00 was considered rejected. Exceptionally Good = 5point, Above Average = 4point, Average = 3point, Below Average = 2point and Poor = 1point. 5+4+3+2+1 = 15, 15/5 = 3.00 as decision rule. The entire null hypotheses were tested at 0.05 levels of significance. The null hypotheses were rejected if the p-value is less than 0.05 level of significant and accepted if the p-value is more than 0.05 level of significant.

Results and Discussion

The result and discussion of findings were presented below:

Results

The results were presented below:

Research Question One

What is the mean difference between the urban and rural Domestic Installation students' interest scores toward Hauenstein psychomotor Model in technical colleges before the implementation?

The evidence from the statistical outcome documented in table 2 indicated the mean difference of pre-test interest scores of experimental (Urban Technical College) and control (Rural Technical College) groups. The pre-test interest scores of experimental (M = 3.48, SD = 1.141, S.E = .185) and control group (M = 3.30, SD = 1.245, S.E = .193). *This result indicated that there was a trivial difference (0.118) in the interest scores of the two groups in terms of their learning interest in Domestic Installation before the implementation.*

Table 2: Descriptive Statistics of Pre-Test Interest Scores of Urban and Rural Technical Colleges

Name of School	N	Mean (X)	Std. Dev. (SD)	S.E.	Mean Difference
GDTCB (Urban)	**38**	**3.48**	**1.141**	**0.185**	
					0.18
GDTKM (Rural)	**41**	**3.30**	**1.245**	**0.193**	

Source: Field work, 2023

Research Question Two

What is the mean difference between the urban and rural Domestic Installation students' interest scores toward Hauenstein psychomotor Model in technical colleges after the implementation?

Table 3 documented a descriptive statistic of *the* effect of Hauenstein psychomotor model on learning interest of Urban and Rural Technical College students in Domestic Installation in Bauchi state. The result in table 3, revealed that there was a difference in the interest scores of Urban Technical College students (M = 4.84, SD = 1.063, S.E = .177) and *Rural Technical College* students (M = 3.52, SD = 1.145, S.E = .179). *This indicated that, the students of blended Urban Technical College have high (1.84) learning interest in Domestic Installation than their counterparts in Rural Technical College.*

Table 3: Descriptive statistics of post-test mean interest scores of urban and rural technical colleges

Name of School	N	Mean (X)	Std. Dev. (SD)	S. E.	Mean Difference
GDTCB (Urban)	**38**	**4.84**	**1.063**	**0.177**	**1.38**
GDTCKM (Rural)	**41**	**3.52**	**1.145**	**0.179**	

Source: Field work, 2023

Result of Testing Null Hypotheses

An independent sample t-test was formulated to test null hypotheses 1-2, the two null hypotheses were tested to achieve objectives of the study and the Domestic Installation Interest Inventory (DIII) pre-survey and post-survey scores were statistically analyzed at 0.05 level of significant and the results interpreted. In testing the null hypotheses if the p-value is greater than 0.05 level of significant the null hypotheses were accepted, this indicate insignificant difference exist between the variables. On the other hand, if the p-value is less than 0.05 level of significant the null hypothesis were rejected, this implies that significant differences exist between the variables.

Null Hypothesis One

$H_{01:}$ There is no significant difference between urban and rural Domestic Installation students mean interest scores toward Hauenstein psychomotor Model in technical colleges before the implementation.

The evidence from the statistical outcome documented in table 4 indicated that indicated that statistically there was non-existence of significant difference in the pre-test interest scores of Urban Technical College (M = 3.48, SD = 1.141) and Rural Technical College (M = 3.30, SD = 1.235), t-value = 0.669, p = .506. Therefore, this result supports the prediction of null hypothesis one that said there is no significant difference between urban and rural Domestic Installation students mean interest scores toward Hauenstein psychomotor Model in technical colleges before the implementation. The null hypothesis one was accepted.

Table 4: Independent Samples T-Test of Pre-Test between urban and rural students

Name of Sch.	N	Mean (X)	SD	d_f	t-val	p-val	Remark
GDTCB	**38**	**3.48**	**1.141**	**77**	**0.669**	**0.506**	**Accepted**
GDTCKM	**41**	**3.30**	**1.235**				

Source: Field work, 2023

Null Hypothesis Two

$H_{02:}$ There is no significant difference between urban and rural Domestic Installation students mean interest scores toward Hauenstein psychomotor Model in technical colleges after the implementation.

The statistical evidence presented the *independent-samples t-test* in table 5 indicated that there is a statistically significant difference in the mean post-test scores of students (Urban Technical College) taught Domestic Installation using Hauenstein psychomotor model (M = 4.84, SD = 1.063) and those taught using conventional (Rural Technical College) approach ((M = 3.52, SD = 1.145), t-val = 1.289, p = .000. Null hypothesis 2 is therefore, rejected.

This finding suggested that the interest of students exposed to Hauenstein psychomotor model (Urban Technical College)is significantly better than that of their counterparts in conventional (Rural Technical College) approach.

Table 5: Independent Samples T-Test of Post-Test between urban and rural students

Name of Sch.	N	Mean (X)	SD	d_f	t-val	p-val	Remark
GDTCB	**38**	**4.84**	**1.063**				
				77	**1.289**	**0.000**	**Rejected**
GDTCKM	**41**	**3.52**	**1.145**				

Source: Field work, 2023

Discussion of Findings

The findings of the research work were discussed by explaining the result found on the research questions, research hypotheses tested and the result of the null hypotheses were tested at 0.05 level of significant and was explained one after the other.

In research question one, pre-test mean scores of urban technical college compared stood at 3.48 which are insignificantly higher than that of rural technical college which stood at 3.30. The difference is trivial, showing that the pre-test learning interest of the two technical colleges toward Hauenstein psychomotor model is almost the same before the implementation. Discussion also from the finding that was obtained from the null hypothesis that "there is no significant difference between urban and rural Domestic Installation students mean interest scores toward Hauenstein psychomotor Model in technical colleges before the implementation", it is evidently clear that t-value of 0.669 and the p-value stood at 0.506 which is greater than 0.05 level of significant and this shown insignificant different between the two technical colleges (urban and rural technical colleges), therefore the null hypothesis one was accepted. The findings agreed with the thought of Sambo, (2015) that entry knowledge of experimental and control group have to be equal in experimental research.

In research question two; the post-survey learning interest of the students in both urban and rural technical colleges was found to be 4.84 and 3.52 and the standard deviation 1.063 and 1.145 respectively. The result showed that difference exists between the students learning interest scores of the two technical colleges (urban and rural technical colleges). Moreover, the null hypotheses two had being tested using independent sample t-test, the output of the analysis revealed that the t-value at 0.05 level of significant is 1.289, the p-value stood at 0.000 which is less than 0.05 level of significant and this shows significant different in the students learning interest of both urban and rural technical colleges. The finding further disclosed that learning interest ability of students exposed to Hauenstein psychomotor model is significantly better than that of their counterparts in conventional approach. The finding is consistent with the findings of the prior studies such as Okekeokosisi and Okigbo, (2021) who reported that interest ability of secondary students was significantly enhanced when exposed to Hauenstein psychomotor model. Similar finding was reported by Alabekee, Samuel and Osaat (2015) in mathematics.

This indicated that the students learning interest in urban and rural technical colleges had significant difference, and provided a basis on which it could be reasonably assumed that both technical colleges had different learning interest. It is further affirmation that there is a significant difference between students' means learning interest scores in post-test of experimental (urban technical college) and control (rural technical college) groups. The findings of this research therefore is expected to fill the existing teaching and learning gap, as this study was conducted in the subject Domestic Installation found to be very effective in technical colleges in Bauchi State.

Conclusion

Based on the findings of the study, it was concluded that Hauenstein psychomotor model is an effective method of teaching Domestic Installation (DI). Therefore, Hauenstein psychomotor model could be used in the teaching and learning of Domestic Installation to enhance students' learning interest, performance, mastery of Domestic Installation knowledge and skills.

Recommendations

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

1) Domestic Installation teachers in Technical Colleges should use Hauenstein practical skill acquisition model in teaching Domestic Installation to enhance student's mastery in practical skills acquisition and academic performance.
2) Domestic Installation students should be encouraged to use Hauenstein practical skill acquisition model in the learning of Domestic Installation since it enhances academic performance and eventually aid mastery of practical skill acquisition of students.
3) Technical College administrators should provide instructional facilities for using Hauenstein practical skill acquisition model. Also, Domestic Installation teachers should be given opportunities by the administrators for in-service training to equip them with the skills required in the use of Hauenstein practical skill acquisition model for teaching Domestic Installation.

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POST GRADUATE STUDENTS' AWARENESS AND SELF-EFFICACY OF USING ACADEMIC SOCIAL NETWORKING SITES IN NORTH CENTRAL NIGERIA

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Abstract

Academic Social Networking Sites (ASNSs), including platforms like Academia.edu, ResearchGate, and LinkedIn, are dedicated tools aimed at facilitating academic collaboration, the dissemination of research, and professional networking. This study examines postgraduate students' awareness of and self-efficacy in utilizing academic social networking sites within North-Central Nigeria. Two research questions guided the study and were addressed descriptively through a cross-sectional survey involving 646 postgraduate students, purposively selected from

nine universities across Kwara, Kogi, and Niger States. A researcher-designed questionnaire titled "investigating postgraduate student's awareness and self-efficacy in using academic social networking sites in North-central Nigerian" was administered through Google form to elicit responses from the sampled postgraduate students. The data collected were analyzed using descriptive statistics. The level of significance was set at <0.05. The respondents from federal universities constituted 51.2% of the population, those in state universities made up 37.5% of the respondents while the private universities are 11.3%. Analysis of the result revealed that the level of awareness of ASNS was high, with a mean score of 3.09, while the level of self-efficacy was moderate (mean = 2.91). In conclusion, the findings highlighted the importance of promoting awareness and self-efficacy among postgraduates towards ASNS to improve academic networking and academic collaborations.
***Keywords**: Academic Performance Critical Thinking, , Digital Learning Flipgrid, Student Engagement,*

Introduction

In a general context, awareness can be described as the state or ability to perceive, feel, or be conscious of events, objects, or sensory patterns. This perception or understanding may relate to internal or external stimuli and can occur either in relation to specific phenomena or more broadly. Awareness exists in multiple dimensions and levels, including self-awareness, situational awareness, emotional awareness, digital awareness, information awareness, global awareness, and cultural awareness, depending on the context in which it is required (Orr, 2023). These various forms of awareness collectively foster collaborative and knowledge-sharing environments, particularly within academic social networking contexts, where meaningful connections and enriched academic experiences are promoted. Although direct studies linking each type of awareness to academic social networking sites are limited, broader research on academic networking, online collaboration, and educational uses of social media underscores their relevance.

The awareness of academic social networking sites (ASNSs) remains less widespread compared to general social media platforms such as Facebook, LinkedIn, and WeChat. Individuals outside academic communities are often unaware of the existence and potential value of ASNSs, despite growing recognition of these platforms within academic circles, where they are increasingly used for connecting students, academics, and researchers, as well as for sharing scholarly outputs and fostering research collaboration (Hailu & Wu, 2021). A study conducted among library and information science professionals in India revealed that awareness of ASNSs was relatively low among the general population, with only 40 percent of respondents having prior knowledge of such platforms (Stephen & Pramanathan, 2021). The study further identified ResearchGate as the most popular ASNS, followed by Academia.edu and Google Scholar. Existing literature largely concentrates on awareness levels among specific academic stakeholders such as students, lecturers, and researchers, while fewer studies address broader public understanding of ASNSs (Jain & Makwana, 2022).

Empirical evidence suggests variations in awareness across academic groups. For instance, a study among female academics in an Indian university found that Google Scholar was the most widely used ASNS, with most respondents maintaining at least one ASNS profile. Awareness was primarily gained through colleagues and friends, and the platforms were mainly used for accessing scholarly articles and disseminating research outputs. However, lack of awareness remained a major barrier to wider adoption (Sripathi, 2024). Similarly, a study conducted in Oyo State, Nigeria, revealed that many postgraduate students were not fully aware of ASNS platforms despite their potential benefits for academic collaboration and scholarly interaction (Ishola et al., 2020).

Awareness of ASNSs among academic staff tends to be higher, likely due to the platforms' usefulness for research dissemination, collaboration, and enhanced communication within academic communities. These benefits may partly explain the increasing level of awareness among students in recent years. For example, Ali et al. (2022) reported that 96 percent of researchers were aware of at least one ASNS, with 81 percent using them regularly. Similarly, a study conducted in Egypt showed high awareness levels among academic staff, with over 85 percent familiar with major platforms such as Academia.edu, LinkedIn, ResearchGate, and Google Scholar (El-Berry, 2015). Research conducted in Tamil Nadu, India, also revealed moderate awareness levels among academics, influenced by factors such as age and academic qualification, with extensive use of web resources contributing to familiarity with ASNSs (Jeyapragash & Arputharaj, 2017).

The primary function of ASNSs is to facilitate connections among students and promote collaboration on academic tasks and research projects. These functions enhance access to academic support and scholarly resources, which may explain students' growing awareness of these platforms (Megwalu, 2022). Students with greater exposure to academic social media tend to experience improved academic outcomes due to access to course materials, research articles, expert opinions, and enhanced communication with supervisors and peers (Valdez et al., 2020). Such interactions support meaningful academic engagement and improved learning experiences.

Self-efficacy refers to an individual's belief in their ability to successfully perform tasks and achieve desired outcomes. Rooted in Bandura's social cognitive theory, self-efficacy is defined as individuals' judgments of their capacity to organize and execute actions required to attain specific goals (Bandura, 1997). Importantly, self-efficacy extends beyond mere confidence in success to include belief in one's ability to take the necessary steps to achieve that success (Sarman et al., 2025).

In the context of social networking site usage, self-efficacy has been identified as a key theoretical framework for understanding students' beliefs and performance. Almarwaey (2017) examined the use of social networking sites among students at Umm Al-Qura University and found that communication with peers and dissemination of academic materials were the primary motivations for usage. The study reported a significant positive relationship between ASNS usage and students' self-efficacy. Self-efficacy influences essential behaviors such as goal setting, persistence, effort, and resilience in the face of challenges, all of which contribute to academic success (Schunk & DiBenedetto, 2021).

Self-efficacy is dynamic and evolves with experience, knowledge acquisition, and contextual factors (Pabis, 2025). Researchers have identified several strategies for enhancing self-efficacy among students, including setting achievable goals, embracing challenges, learning from failure, and seeking social support from peers, lecturers, and experts (Puozzo & Audrin, 2021). Consequently, self-efficacy is widely recognized as a critical determinant of students' academic achievement.

Previous studies examining the relationship between social networking site usage and academic self-efficacy have produced mixed findings. While some studies report positive associations, others indicate negative or insignificant relationships. For instance, Boahene et al. (2019) found a positive relationship between students' academic self-efficacy and educational use of social media in Ghanaian higher institutions, with self-efficacy mediating academic performance. Variations in technological self-efficacy, such as computer, internet, and learning management system self-efficacy, have also been shown to influence online learning outcomes differently (Alqurashi, 2016; Prifti, 2022).

Academic social networking sites have been shown to enhance students' self-efficacy by supporting collaboration, academic engagement, and performance. Students who possess higher self-efficacy are more likely to engage effectively with ASNSs, while regular and purposeful use of these platforms further strengthens self-efficacy (Kouser, 2020; Adeniyi et al., 2016). However, misuse of ASNSs can lead to distractions and negative feedback, potentially undermining academic performance and self-efficacy. Therefore, it is essential for students to harness ASNSs strategically to maximize their academic benefits.

Purpose of the study

This study examined the awareness and self-efficacy related to academic social networking sites among postgraduate students in North-Central universities in Nigeria. Specifically, it evaluated their level of awareness and assessed the self-efficacy associated with the use of academic social networking sites (ASNSs) among postgraduate students in North-Central Nigeria.

Research Questions

The study addressed the research questions raised:

1. To what extent are postgraduate students in North-Central Nigeria aware of academic social networking sites?
2. What is the self-efficacy level regarding the use of academic social networking sites among postgraduate students in North-Central Nigeria?

Method and Material

Study Design

This study employed a descriptive research design using a cross-sectional survey approach, with data collected through a questionnaire distributed via Google Forms. It focused on exploring the awareness and self-efficacy of postgraduate students in using academic social networking sites across North-Central Nigeria. The study population included all postgraduate students enrolled in universities within the North-Central Geopolitical Zone, covering Kwara, Kogi, Plateau, Nasarawa, Niger, and Benue States. However, the target group was specifically postgraduate students from universities in three purposively selected states: Kwara, Kogi, and Niger. The target population figure is 646.

Data Presentation

The demographic information of the respondents and the results of the analysis are presented in tables and figures.

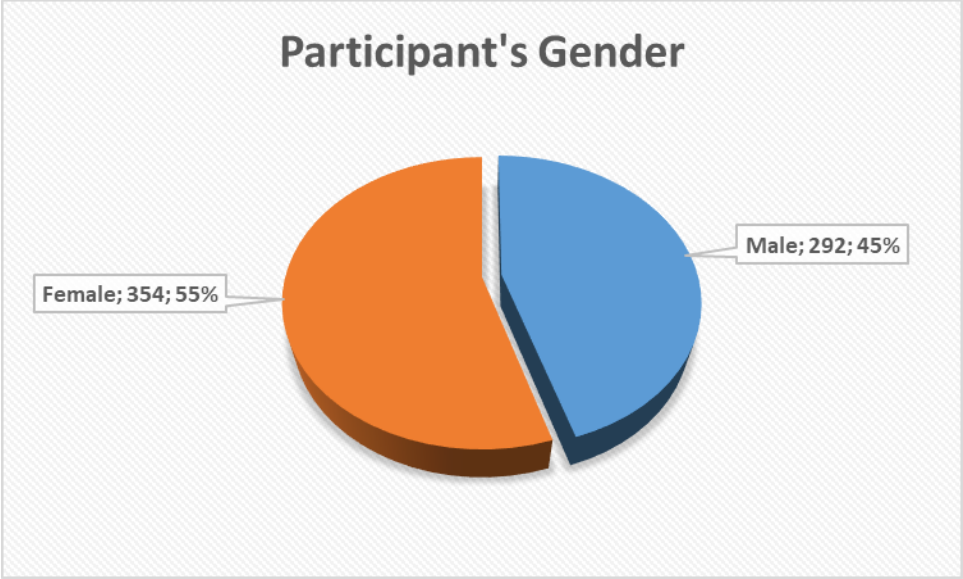

Figure 1: Distribution of respondents based on gender

Figure 1 shows the gender distribution of the respondents. Out of the total 646 respondents, 354 (55%) are female, while 292 (45%) are male. This reflects a slightly greater representation of females in the sample.

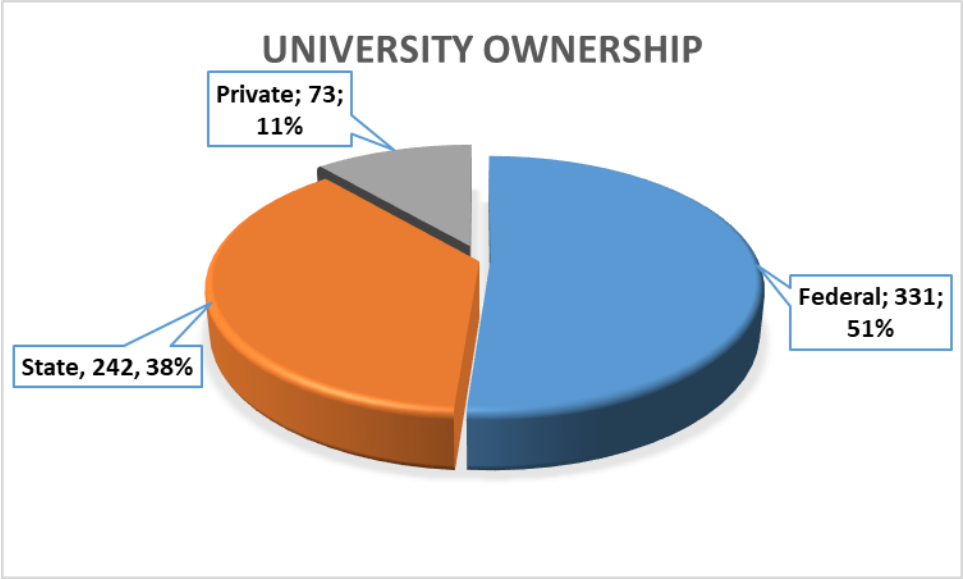

Figure 2: Distribution of respondents based on university ownership

Figure 2 illustrates the distribution of respondents based on the ownership of the University they are affiliated with. Among the 646 respondents, the majority, 331 respondents (51%), are from federal institutions. state institutions make up of 242 (38%) of the respondents, while private institutions have the smallest representation with 73 (11%).

Research question 1: To what extent are postgraduate students in North-Central Nigeria aware of academic social networking sites?

Table 1
The extent of postgraduate students' awareness of academic social networking sites in North-Central Nigeria

S/N	Item	Mean
1	I am aware that there are different types of academic social networking sites (ASNS) relevant to my field of study.	3.27
2	I am aware that there are potential benefits in using ASNS for academic collaboration.	3.16
3	I am aware that there are specific features offered by different ASNS platforms.	3.03
4	I am aware that there are relevant groups on ASNS for my academic interests.	3.03
5	I am aware that there are etiquette for engaging with others on ASNS in an academic context.	3.07
6	I am aware that there are challenges associated with using ASNS for academic purposes (e.g., data privacy, misinformation).	3.02
7	I am aware that one can always distinguish between reliable academic information sources on ASNS.	3.12
8	I am aware that there are resources available at my university to help me use ASNS effectively	3.01
	Grand mean	**3.09**

Table 1 presents information on the level of awareness of postgraduate students in North-central Nigeria regarding Academic Social Networking Sites (ASNS). The result reveals that item 1 recorded the highest mean score of 3.27, suggesting that the majority of postgraduate students are familiar with various types of academic social networking sites (ASNS) related to their areas of study. This was followed by item 2 with a mean score of 3.09, which indicates that postgraduate students are aware that there are potential benefits in using ASNS for academic collaboration. The item with the lowest mean score of 3.01 was item 8, which inquired if postgraduate students are aware of resources available at their universities for them to use ASNS effectively. The grand mean score for awareness of ASNS by postgraduate students in north-central Nigerian university was 3.09 which is greater than the benchmark of 2.50 (since it is a 4 Likert scale response mode). This shows that level of awareness of postgraduate students of Academic Social Networking Sites in North-central, Nigeria is high.

Research question 2
What is the self-efficacy level regarding the use of academic social networking sites among postgraduate students in North-Central Nigeria?

Table 2
Self-efficacy levels in the use of academic social networking sites among postgraduate students in North-Central Nigeria

S/N	Item	Mean

1	I possess the knowledge to create a profile on Academic Social Networking Sites (ASNS) (e.g., ResearchGate, Academia.edu)	2.82
2	I am confident in my ability to share my research work on ASNS.	2.95
3	I can effectively use ASNS to network with other researchers.	2.85
4	I am capable of following current research trends on ASNS.	3.04
5	I can utilize ASNS to connect with potential collaborators for research projects.	2.77
6	I am confident in my ability to join and participate in academic groups and forums on ASNS.	2.80
7	I can use ASNS to search for professional events such as conferences, workshops and training.	3.03
8	I am able to tract and impact the citations of my work through ASNS analytical tools.	2.98
9	I can utilize supplementary academic resources such as papers and articles on ASNS.	2.97
10	I am confident in my ability to manage privacy and security settings to protect my academic work on ASNS.	2.91
	Grand mean	**2.91**

Table 2 assesses self-efficacy levels in the use of academic social networking sites among postgraduate students in North-Central Nigeria. The result shows that item 4, which assessed the capability of postgraduate students to follow current research trends on ASNS, has the highest mean score of 3.04. This was closely followed by item 7 with the mean score of 3.03. This item assessed the ability of postgraduate students to use ASNS to search for professional events such as conferences, workshops and training. However, item 5 that inquired if the students can utilize ASNS to connect with potential collaborators for research projects has the lowest mean score of 2.77. The grand mean for the questionnaire assessing the efficacy of postgraduate students on ASNS was 2.91. This indicates that the level of self-efficacy of the respondents was moderate, because it was slightly above the benchmark of 2.50.

Results and Discussion

This study examined postgraduate students' awareness of and self-efficacy in using academic social networking sites across universities in North-Central Nigeria. Findings addressing the first research question revealed a high level of awareness of ASNSs among postgraduate students. This result aligns with previous studies that reported increasing awareness of academic social networking platforms among students and academic communities (Nse Akwang, 2022). The widespread availability of internet access and the growing reliance on digital platforms for scholarly communication may have contributed to this heightened awareness.

Despite the high level of awareness, postgraduate students demonstrated only a moderate level of self-efficacy in using ASNSs. This finding supports earlier research suggesting that awareness of digital tools does not automatically translate into confidence or proficiency in their use. Almarwaey (2017) similarly reported a positive association between social networking site usage and academic self-efficacy, emphasizing that meaningful engagement rather than mere awareness determines self-efficacy development.

The moderate self-efficacy levels observed in this study contrast with findings by Boahene et al. (2019), who reported a significant positive impact of social media usage on academic self-efficacy and performance among tertiary students. This discrepancy may be attributed to contextual differences, variations in institutional support, or differences in students' technological competencies. Additionally, Alqurashi (2016) identified multiple dimensions of self-efficacy, including computer, internet, and learning management system self-efficacy, that influence students' online learning experiences. These dimensions may explain the diverse perceptions of self-efficacy reported among postgraduate students in the present study.

Overall, the results indicate that although postgraduate students in North-Central Nigeria are highly aware of academic social networking sites, deliberate efforts are needed to enhance their confidence and competence in using these platforms effectively. Structured training, institutional support, and guided academic engagement on ASNSs could help transform awareness into sustained academic collaboration and improved research productivity.

Conclusion

This study investigated the awareness and self-efficacy of Academic Social Networking sites among Postgraduate students in North-central Universities in Nigeria. The finding revealed that postgraduate students in North-central Nigeria demonstrated a moderate level of awareness and confidence in their ability to use academic social Networking Sites (ASNS). Since the level of awareness was high among postgraduate students, universities in North-Central Nigeria could consider integrating ASNS more formally into academic programs to take advantage of this awareness for academic networking and collaboration. The moderate self-efficacy levels among postgraduate students suggest a need for targeted training sessions to build confidence and proficiency in ASNS usage, which could also enhance students' academic networking capabilities. Similarly, there should be organization of workshop and seminar programs that will enlighten the students on the level of awareness and self-efficacy among postgraduate students in North-Central universities.

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EFFECT OF LABORATORY EXPERIMENTS ON STUDENTS ACADEMIC ACHIEVEMENT AND RETENTION OF CHEMISTRY CONCEPTS IN LOKOJA LOCAL GOVERNMENT AREA, KOGI STATE

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Abstract

This study investigated the effect of laboratory experiments on the academic achievement and retention of chemistry concepts among Senior Secondary School II (SS II) students in Lokoja Local Government Area, Kogi State, Nigeria. A quasi-experimental pre-test, post-test control group design was adopted for the study. Two research questions and two hypotheses were formulated and tested at the 0.05 level of significance. The study population comprised 1,300 SS II chemistry students, while 120 students were purposively sampled. Students were assigned to an experimental group (n=60, taught with laboratory experiments and a control group (n=60) taught with the conventional lecture method. Data were collected using 40 multiple-choice items Chemistry Achievement and Retention Test (CART) as the instrument for data collection. The pre-test, post-test, and retention test scores were analysed using mean and standard deviation while t-tests and analysis of covariance (ANCOVA) were used to test hypotheses. The instrument was validated by three experts in Science Education / Measurement and Evaluation departments, Federal University Lokoja. A pilot test using Kuder-Richardson 21 yielded a reliability coefficient of 0.75. Results showed that the experimental group significantly outperformed the control group in post-test and retention test scores, indicating superior achievement and retention with laboratory experiments method. No significant gender differences were found in the experimental group, but the findings showed the effectiveness of the laboratory experiment method. The study therefore recommended the adoption and integration of laboratory experiments method into the chemistry curriculum and providing regular training for the chemistry teachers.

Keywords: *Laboratory Experiments, Chemistry Concepts, Academic Achievement, Retention, students*

Introduction

Chemistry as a fundamental science subject plays a vital role in the development of scientific literacy and technological advancement. It provides students with the knowledge and skills necessary to understand the composition, structure, and properties of matter, as well as the changes it undergoes during chemical reactions. However, despite its importance, students often perceive chemistry as a challenging subject due to its abstract nature and the complexity of its concepts (Hofstein and Lunetta, 2024). This perception has led to poor academic achievement and low retention of chemistry concepts among students, particularly at the senior secondary school level. Students' achievement is a reflection of their academic progress, personal growth, and the development of skills that prepare them for future challenges. It encompasses not only grades and test scores but also the acquisition of critical thinking, creativity, collaboration, and problem-solving abilities. Achievement is a multifaceted concept that highlights the efforts of students, the support of educators, and the involvement of families and communities. Academic excellence is often measured through grades, standardized test scores, and performance in coursework. High academic performance demonstrates a student's mastery of subject matter, dedication to learning, and ability to meet educational standards. However, it is important to recognize that academic success is not solely about high grades but also about understanding concepts, applying knowledge, and engaging in lifelong learning (Ezeano and Ugwu 2024). According to Ezeano and Ugwu (2024), achievement goes beyond academics and as a matter of fact engulfs the development of soft skills such as communication, time management, resilience, and emotional intelligence. Retention, defined as the ability to retain and recall learned information over time, is a critical aspect of effective learning. In chemistry education, retaining knowledge is crucial for students to grasp fundamental ideas and use them in more complex situation.However,the adoption of conventional lecture teaching approach frequently centered on lectures and memorization has been questioned for its failure to promote meaningful comprehension and lasting retention of chemical principles (Aminu, 2020). As a result, there is a growing need to investigate different teaching methods that can improve students' retention and grasp of chemistry. One effective approach is incorporating laboratory experiments into chemistry instruction. Laboratory is a fundamental part of chemistry education, offering students hands-on opportunities to connect theory with real-world practice. By conducting experiments, learners can directly observe chemical reactions, test hypotheses, and participate in problem-solving tasks; all of which are carried out to improve their comprehension and long-term retention of key concepts (Ali et al., 2021). Additionally, laboratory work cultivates critical thinking, creativity, and scientific reasoning, skills that are vital for success in the field of science. Ezeano and Ugwu (2024) investigated the impact of laboratory teaching methods on senior secondary school students' achievement in inorganic chemistry. Their findings revealed that students who engaged in laboratory activities demonstrated significantly higher academic achievement compared to those who did not participate in such practical sessions. Likewise, Ahiakwa (2024) investigated the impact of hands-on learning on students' performance and knowledge retention in stoichiometry. The findings revealed that students who participated in practical laboratory activities scored higher and demonstrated better long-term retention of concepts compared to those taught using

conventional teacher-led demonstrations. Jimoh (2020) conducted a comparative study in Jigawa State, Nigeria, examining how cooperative learning and laboratory methods influence secondary school students' chemistry performance and retention. The results demonstrated that the laboratory approach substantially improved both academic outcomes and knowledge retention, reinforcing the value of hands-on experimentation in deepening conceptual understanding. Supporting these findings, Okoli et al. (2024) studied the impact of laboratory instruction in Ebonyi State, Nigeria, revealing that such methods not only boosted achievement in chemistry but also enhanced students' scientific attitudes and problem-solving abilities. While laboratory experiments hold promise for improving conceptual retention in chemistry, their efficacy remains contested in educational research. Some empirical studies, such as McDuell (2021) demonstrated that carefully structured laboratory activities can alignment with curricular goals or when instructional scaffolding is insufficient. Furthermore, markedly enhance both comprehension and retention of chemical principles. Conversely, the research of Jack (2020) suggests limited retention benefits when experiments lack clear contextual factors, including resource availability, instructor expertise, pedagogical implementation quality, and student engagement with practical work, critically mediate the impact of laboratory methods on long-term knowledge retention. In the context of senior secondary schools, where students are preparing for higher education and careers in science-related fields, the role of laboratory experiments in enhancing retention of chemistry concepts is very important. However, there is limited information on research focusing on this specific educational level, particularly in developing countries where resource constraints and large class sizes may limit the effectiveness of laboratory instruction.

Statement of the Problem

Chemistry is a core subject in the senior secondary school curriculum, essential for students pursuing careers in science, technology, engineering, and mathematics (STEM). However, students often struggle to retain chemistry concepts due to the subject abstract nature and the overreliance on traditional teaching methods, such as lecture method and rote memorization, which do not adequately engage learners or promote deep understanding (Adesoji and Babatunde, 2020). This challenge becomes so worrisome in senior secondary schools, where students are expected to master foundational concepts that are required for success in external examinations and higher education. Laboratory experiments are widely recognized as a vital component of chemistry education, offering students hands-on experiences that can bridge the gap between theoretical knowledge and practical application. Studies have shown that well-designed laboratory activities can enhance students' understanding, critical thinking, and retention of scientific concepts (Adeyemi, 2021). However, the effectiveness of laboratory experiments in improving retention is influenced by factors such as the availability of laboratory resources, serenity of the learning environment, the quality of instruction, and the alignment of experiments with learning objectives (Oloruntegbe and Omoifo, 2020). In most of the senior secondary schools in the Western African subregion, these influential factors are often jettisoned during the implementation stage causing retrogressive outcomes in chemistry education. In Lokoja Local Government Area, Kogi State, the 2022 education sector report reveals a concerning pattern: only 38% of senior secondary chemistry students achieved passing grades on standardized concept retention assessments, while 62% demonstrated insufficient

mastery of foundational topics (Kogi State Ministry of Education, 2022). This persistent underperformance persists despite chemistry's strategic importance in the STEM curriculum, with analysis showing year-on-year concept retention rates stagnating below 45% since 2019. This problem is exacerbated by inadequate laboratory facilities, insufficient training for teachers in conducting effective laboratory experiments, and large class sizes that limit 4 students' access to hands-on learning opportunities (Ezeudu, 2021). Furthermore, there is need for educators to utilize activity oriented strategies in instructional delivery because one of the identified factors causing students abysmal achievement in chemistry is pedagogical factor.Hence, incorporating the laboratory experiments method as a trial strategy to address the problem.

Objectives of the Study

The aim of this study is to investigate the effect of laboratory experiments on students' achievement and retention of chemistry concepts among senior secondary school students in Lokoja Local Government Area, Kogi State. Specifically, the study seeks to address the following issues:

i. To determine the achievement in Chemistry of students taught with laboratory experiments method in selected senior secondary schools in Lokoja Local Government Area, Kogi state.

ii. To examine the achievement in Chemistry of male and female students taught with laboratory experiments.

Research Questions

The following research questions guided the study:

i. What are the mean scores in Chemistry of students taught with laboratory experiments method in selected senior secondary schools in Lokoja Local Government Area of Kogi State?

ii. What are the mean scores in Chemistry of male and female students taught with laboratory experiments method?

Research Hypotheses

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

$H0_1$: There is no significant difference in the mean performance in Chemistry between students taught with traditional teaching methods and those taught with laboratory experiments method.

$H0_2$: There is no significant difference in chemistry achievement between male and female students taught with laboratory experiments method.

Conceptual and Theoretical Framework

Chemistry, often termed the "central science," examines the composition, structure, properties, and transformations of matter. It serves as a critical link between the physical and life sciences, providing foundational knowledge essential for disciplines such as biology, physics, medicine, and environmental science (Ali et al., 2021). Due to its broad applicability, chemistry is considered a cornerstone of scientific education, preparing students for future careers in STEM fields. Ahiakwa (2024) describes it as the "mother of all sciences," emphasizing its interdisciplinary influence

and significance in secondary education. The scope of chemistry extends across all scientific domains. Jimoh (2020) defines it as the study of matter's structure and composition, while Jack (2020) views it as the science of transforming raw materials into useful products—a principle underpinning modern chemical industries. McDuell (2021) further characterizes chemistry as both a body of knowledge and a cognitive framework for problem-solving. Beyond academia, chemistry drives technological innovation, environmental sustainability, and public health. Okoli et al. (2023) highlight its role in addressing global issues like climate change and drug development.

Laboratory experiments strategy has emerged as a transformative pedagogical approach in modern chemistry education, offering students immersive, hands-on learning experiences that bridge theoretical knowledge with practical application. Contemporary research demonstrates that well-designed laboratory activities significantly enhance students' conceptual understanding, critical thinking skills, and long-term retention of chemical principles (Hofstein and MamlokNaaman, 2021). Recent studies emphasize inquiry-based experiments where students actively formulate hypotheses, design procedures, and analyze data, fostering deeper engagement with scientific processes (Ali et al., 2021). Such approaches have proven to be effective in developing problem-solving competencies in stoichiometry and reaction kinetics (Ahiakwa, 2024). The laboratory method provides an alternative learning environment that differs significantly from traditional classroom settings. In chemistry education, this approach allows students to experience science firsthand and develop scientific behaviors through direct engagement (Alaka, 2025). This empirical learning method involves students actively working with laboratory apparatus and materials under proper teacher guidance and technical support. As a practical, activity-based instructional strategy, it creates a learner-centered approach to chemistry education. Hart et al. (2020) emphasize that students particularly enjoy laboratory work due to its active nature and hands-on material manipulation. This method proves valuable in secondary school chemistry education, where students develop fundamental scientific skills that form the basis for future scientific careers. Numerous studies confirm that laboratory work significantly enhances conceptual understanding.These include Özmen, Demircioğlu & Coll, (2020); Woodley (2020) among others. The laboratory method builds scientific skills and processes in chemistry education and also facilitates students interaction with learning materials under teacher supervision, differing from cooperative learning approach that emphasizes teamwork. Both methods, however, contribute to improved academic achievement and better retention of core chemistry concepts. As a cornerstone of science education, laboratory experiments provide crucial hands-on learning experiences that develop conceptual understanding, critical thinking, and scientific inquiry skills. These structured activities involve variable manipulation, phenomenon observation, and evidence-based conclusion . Whether conducted physically or virtually, laboratory work effectively connects theoretical knowledge with practical application (Bazie et al., 2024). In chemistry education, laboratory experiments prove particularly valuable for making abstract and complex concepts more tangible. Practical activities enhance comprehension of chemical reactions, properties, and molecular structures. Udu and Eze (2020) highlight how laboratory work transforms challenging concepts into meaningful learning experiences that surpass simple memorization. Beyond content mastery, laboratory experiments cultivate essential scientific attitudes and skills including observation, measurement, problem-solving, and collaboration. Mohammed et al. (2021) demonstrates that students receiving laboratory-based instruction consistently outperform their peers in assessments and demonstrate superior long-term knowledge retention. Technological advancements have revolutionized laboratory instruction

through innovative implementations. Virtual and augmented reality platforms now enable students to safely simulate hazardous reactions or visualize molecular interactions at the atomic scale (Dalgarno et al., 2023). Digital tools like sensor-based data collection systems and computational modeling software have transformed traditional experiments, allowing for more precise measurements and real-time data analysis (McDuell, 2021). These technological integrations have expanded access to laboratory experiences, particularly in resource-constrained environments where physical equipment may be limited (Jack, 2020). Research indicates that such blended approaches, combining virtual and hands-on elements, can enhance conceptual understanding while maintaining the authentic nature of experimental work (Smith et al., 2023). Current laboratory pedagogy emphasizes contextually relevant experiments that connect classroom learning to real-world applications. Green chemistry principles have been increasingly incorporated, with students investigating sustainable materials and environmentally friendly processes (Zuin et al., 2022). Studies show that when experiments address local environmental or industrial challenges, students demonstrate improved motivation and conceptual retention (Okoli et al., 2024). Furthermore, modern laboratory instruction has evolved to promote equitable participation, with gender-responsive designs that actively engage all learners (Ezeano and Ugwu, 2024). Collaborative experiment formats have proven effective in developing teamwork and communication skills essential for scientific careers. These developments reflect a broader shift towards student-centered laboratory experiences that prioritize authentic scientific practices while accommodating diverse learning needs and contexts.

This study is grounded in two complementary theoretical frameworks that inform the investigation of laboratory experiments' effects on students' academic achievement and retention of chemistry concepts:

1. Constructivist Learning Theory (Piaget, 1950; Vygotsky, 1978) Constructivism posits that learners actively construct knowledge through experiences and reflection rather than passively receiving information. In the context of chemistry education, this theory supports the use of hands-on laboratory experiments as a means for students to:

• Build conceptual understanding by interacting with chemical phenomena firsthand (Piaget's assimilation and accommodation).

• Engage in social learning through collaborative experimentation (Vygotsky's social constructivism and Zone of Proximal Development).

• Develop problem-solving skills by testing hypotheses and analyzing results (inquirybased learning). Constructivism explains why laboratory methods may outperform traditional lectures in enhancing retention and achievement—students learn by doing rather than memorizing, leading to deeper cognitive processing (Bretz, 2022).

2. Cognitive Load Theory (Sweller, 1988) Cognitive Load Theory (CLT) suggests that learning is optimized when instructional methods align with the brain's working memory capacity. Key principles include:

• Reducing extraneous load (e.g., eliminating unnecessary complexity in lab instructions).

• Managing intrinsic load (breaking complex chemistry concepts into manageable steps).

• Enhancing germane load (promoting schema construction through guided experimentation). Cognitive Load Theory helps explain why well-designed labs improve retention;they prevent cognitive overload by:

• Providing visual and kinesthetic reinforcement of abstract concepts e.g. molecular interactions

• Using scaffolded experiments that build complexity gradually (Sweller, 2020). Together, these theories provide a robust foundation:

• Constructivism justifies why active learning (labs) works.
• Cognitive Load Theory explains how to structure laboratories for optimal learning.

Research Design and Methodology

The study adopted a quasi-experimental research design, specifically a pre-test, post-test control group design. This design allows for the comparison between an experimental group taught with laboratory experiments and a control group taught using the traditional lecture method. The design is suitable for educational research aimed at measuring the effects of an intervention on students' performance and retention. The population of this study comprises senior secondary school (SSS II) Chemistry students in public secondary schools in Lokoja Local Government Area of Kogi State with an estimated population of 1,300 students in senior secondary schools SSII class in Lokoja Local Government Area, Kogi State. A total of 120 students was selected from two public secondary schools using purposive sampling technique, based on the availability of laboratory facilities and qualified Chemistry teachers. The selected schools were randomly assigned experimental and control groups. Each group consisted of 60 students. The draft of the Chemistry Achievement and Retention Test (CART) instrument was validated by three experts in Science Education and Measurement and Evaluation from Federal University Lokoja. Their suggestions were incorporated before administration. To determine the reliability of the Chemistry Achievement and Retention Test (CART), a pilot test was conducted on 20 students from a school outside the study area. The data collected was analysed using Kuder-Richardson Formula 21 (KR-21), and a reliability coefficient of 0.75 was obtained and considered appropriate for the study

Pre-test was administered to both the experimental and control groups to assess their baseline knowledge. The experimental group was taught using laboratory experiments/practical activities for a period of 3 weeks, while the control group was taught using the traditional lecture method. At the end of the intervention, a post-test was administered to both groups to measure achievement. After a period of four weeks, a retention test (same as post-test) was administered without prior notice to assess retention of chemistry concepts. A structured questionnaire was also used to gather quantitative data on strategies to improve the effectiveness of laboratory experiments .The data collected were analysed using descriptive statistics of mean and standard deviation) to answer the research questions. Inferential statistics, such as independent sample t-test and Analysis of Covariance (ANCOVA), were used to test hypotheses based on significant differences in achievement and retention between groups at a 0.05 level of significance.

Results

Results are presented in tables according to the research question and their corresponding hypotheses.

Table 1: Descriptive Statistics for Post-Test Scores of Students Taught with Laboratory Experiments

Group	Number of Students	Mean	Std. D	Std. Error	Minimum	Maximum	Mean Gain (PostTest - Pre-Test)
Experimental	**60**	**31.87**	**4.61**	**0.60**	**20**	**39**	**13.25**

Table 1 presents the descriptive statistics of the post-test scores for students in the experimental group who were taught using laboratory experiments. The group comprised 60 students, and the mean post-test score was 31.87, indicating a high level of achievement following the intervention. The standard deviation (SD) was 4.61, which suggests moderate variability in the students' scores. The standard error of the mean was 0.60, reflecting the precision of the mean score estimate. The minimum score recorded in the post-test was 20, while the maximum score was 39, out of a total possible score of 40, demonstrating a generally strong performance across the group. Notably, the mean gain, calculated as the difference between post-test and pre-test scores was 13.25, showing substantial improvement in performance after the laboratory-based instructional method. These results suggest that the use of laboratory experiments had a positive impact on students' understanding and achievement in Chemistry.

Table 2:ANCOVA Results for Post-Test Scores (Experimental vs. Control)

Group	**Mean**	**Std. D**	**df**	**ANCOVA F (1,117)**	**pvalue**	**η^2**
Experimental	**31.87**	**4.61**	**118**	**98.56**	**<0.001**	**0.46**
Control	**21.98**	**6.29**				

Table 2 presents ANCOVA results used to evaluate the effect of laboratory experiments on students' post-test scores in chemistry. The experimental group had a mean post-test score of 31.87 with a standard deviation of 4.61, while 34 the control group had a mean of 21.98 and a standard deviation of 6.29. To strengthen the analysis, an Analysis of Covariance (ANCOVA) was conducted to control for possible pre-existing differences using pre-test scores as the covariate. The ANCOVA results also showed a statistically significant effect of the teaching method on post-test scores ($F(1, 117) = 98.56$, $p < 0.001$), with a partial eta squared (η^2) of 0.46, which is considered a large effect size. This means that 46% of the variance in post-test scores can be attributed to the teaching method, after accounting for pre-test differences. Both the t-test and ANCOVA results lead to the rejection of the null hypothesis (H_{01}), confirming that the use of laboratory experiments had a significant and substantial positive impact on students' academic achievement in chemistry.

Table 3: Descriptive Statistics for Post-Test Scores by Gender in the Experimental Group

Group	Number of Students	Mean	Std. D	Std. Error	Minimum	Maximum	Mean
Female	35	32.13	3.92	0.69	21	39	12.41
Male	25	30.86	5.23	0.99	20	39	13.43

Table 3 displays the descriptive statistics of post-test scores for male and female students within the experimental group who were taught using laboratory experiments. The female group consisted of 35 students, with a mean post-test score of 32.13, a standard deviation of 3.92, and a standard error of 0.69. Their scores ranged from a minimum of 21 to a maximum of 39, and their mean gain from pre-test to post-test was 12.41, indicating notable improvement.

The male group, consisting of 25 students, had a slightly lower mean score of 30.86, with a standard deviation of 5.23 and a standard error of 0.99. Their scores ranged from 20 to 39, and they recorded a mean gain of 13.43, slightly higher than that of the females. Overall, while female students outperformed males slightly in terms of average post-test scores, male students showed a marginally greater improvement (mean gain) from pre-test to post-test. This suggests that both genders benefited from the laboratory experiment method, though in slightly different ways.

Table 4: T-Test Results for Post-Test Scores by Gender (Experimental Group)

Gender	Number	Mean	Std. D	t-value	Df	p-value
Female	35	32.13	3.92	1.18	58	0.243
Male	25	30.86	5.23			

($p = 0.243 > 0.05$)

Table 4 presents the results of an independent samples t-test conducted to determine whether there was a significant difference in post-test scores between male and female students within the experimental group. The female students ($n = 35$) had a mean post-test score of 32.13 with a standard deviation of 3.92, while the male students ($n = 25$) had a slightly lower mean score of 30.86 and a higher standard deviation of 5.23. The calculated t-value was 1.18 with 58 degrees of freedom and a p-value of 0.243. Since the p-value is greater than the conventional threshold of 0.05, the result is not statistically significant. This implies that there was no significant gender difference in the post-test scores among students taught using laboratory experiments, indicating that the instructional method was equally effective for both male and female students. Hence, the t-test results fail to reject $H0_2$ ($p = 0.243 > 0.05$).

Discussion of Findings

Academic achievements of students when exposed to laboratory experiments

The results of this study provide strong empirical evidence that laboratory experiments significantly enhance both students' academic achievement and long-term retention in chemistry when compared to the traditional lecture method. Specifically, the experimental group, which was exposed to laboratory-based instruction, achieved a higher post-test mean score than the control group in table 1. These findings strongly support the notion that active, hands-on learning facilitates deeper comprehension of scientific concepts, enabling students not only to perform better in immediate assessments but also to retain information more effectively over time. This outcome aligns with constructivist learning theories, which emphasize that knowledge is best acquired through active engagement, exploration, and personal experience. Laboratory experiments embody these principles by providing students with direct interaction with materials and procedures, thereby transforming abstract concepts into tangible understanding. The findings of this study are consistent with the works of Ezeano and Ugwu (2024) and Ahiakwa (2024), who also reported a significant positive impact of experimental-based learning on science achievement. Furthermore, the large effect sizes found in this study are indicative of not just statistical significance, but also practical relevance, suggesting that laboratory instruction yields meaningful improvements in student learning outcomes.

Academic achievement of male and female students taught with laboratory experiments

A key aspect of this study was also the examination of gender-related differences within the experimental group. The independent samples t-test revealed no statistically significant difference in post-test scores between male

and female students. Female students had a slightly higher mean score than male students, but the difference was not enough to be considered significant in table 4. This finding resonates with the research of Adeyemi (2021), who found that when both genders are equally exposed to engaging and participatory teaching methods, the gap in academic performance diminishes. It implies that the laboratory approach provides an inclusive learning environment that benefits all students, regardless of gender, likely due to its ability to accommodate various learning styles and encourage collaborative problem solving.

Conclusion

The study concludes that laboratory experiments method is an effective instructional strategy for improving students' academic achievement and long-term retention in chemistry. Students who engaged in hands-on laboratory work performed significantly better than those who received conventional lecture-based instruction. This implies that laboratory methods promote deeper understanding and meaningful learning of scientific concepts. Furthermore, gender was not a determining factor in performance among students taught with laboratory experiments, indicating that the strategy is inclusive and beneficial for both male and female learners.

Recommendation

The study therefore recommends the adoption and integration of laboratory experiments method into the chemistry curriculum, the school management should to ensure adequate usage of modern laboratory equipment and facilities, and also encourage the science teachers to go for regular refresher course to up-date their knowledge about the modern laboratory facilities for improve outcome in students. The male and female students should be encouraged to attend always attend science laboratory classes in other to enhance their knowledge in laboratory experiments.

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EMPOWERING EDUCATORS THROUGH EDTECH INTEGRATION FOR SKILL DEVELOPMENT AND INCLUSIVE PEDAGOGICAL PRACTICE IN TERTIARY INSTITUTIONS IN SOKOTO STATE

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Abstract

This study investigated lecturers' perceptions of EdTech integration for skill development and inclusive pedagogical practices in public universities in Sokoto State, Nigeria. Guided by three constructs, pedagogical beliefs and resistance, institutional support, and challenges in digital skill development, the study employed a descriptive survey design and a quantitative approach. A multi-stage sampling technique was used to select 346 respondents from a population of 1,809 educators across three public universities. Data were collected using the researcher-developed Educational Technology Integration Questionnaire (ETIQ), which was validated by experts and demonstrated strong internal consistency (Spearman-Brown coefficient = 0.864). Descriptive statistics, including mean scores and standard deviations, were used for analysis with the aid of SPSS. Findings revealed a moderate level of resistance to EdTech, shaped more by emotional discomfort and practical constraints than by ideological opposition. Institutional support was found to be inconsistent, often hindered by policy ambiguity and weak follow-up mechanisms. While professional development opportunities were present, they lacked contextual relevance and failed to equip educators with inclusive digital teaching strategies. Despite available infrastructure, lecturers reported limited access to functional tools and support systems, further constraining effective integration. Based on these findings, the study recommends developing belief-sensitive digital training tailored to institutional contexts, strengthening policy frameworks that encourage innovation, and establishing ICT support systems to sustain EdTech integration.

Keywords: Pedagogical Beliefs, Lecturer Resistance, Institutional Support, Digital Skill Development, Inclusive Pedagogy

Introduction

The rapid advancement of educational technology (EdTech) has redefined instructional delivery and pedagogical engagement across global educational systems. In Nigeria, the increasing pressure on tertiary institutions to modernise teaching practices has prompted the integration of digital tools in teaching and learning environments (Nwuke & Yellowe, 2025). However, while digital technologies are gradually becoming visible in Nigerian higher education, the level of integration remains uneven, especially in the northern regions such as Sokoto State, where

infrastructure gaps and policy inertia persist. For educators to thrive in such contexts, empowerment through EdTech becomes vital, not merely through access to tools, but through meaningful support, training, and systemic inclusion that enable effective, inclusive pedagogical transformations (Msimango, 2025).

Empowering educators with technological tools is not just a technical initiative but a strategic response to 21st-century demands for skill-oriented, inclusive, and adaptive teaching. Tertiary educators require more than digital awareness; they must be competent to translate digital affordances into student-centred learning experiences (Rambe, 2023). EdTech integration supports instructional creativity, collaboration, and differentiation, especially in large or diverse classrooms. Nevertheless, educators' ability to use these tools effectively hinges on systemic support, relevant professional development, and enabling policies that position them as active agents in educational change, rather than passive recipients of technology (Fitriyah, 2025).

Moreover, inclusive pedagogical practice in Nigeria's tertiary institutions remains under-researched in relation to EdTech. Inclusion transcends physical access to classrooms; it involves creating equitable learning experiences for students with diverse needs, backgrounds, and learning styles (Kushwaha et al., 2024). With EdTech, educators can offer differentiated instruction, multimodal content delivery, and adaptive learning support that addresses these variabilities. However, in under-resourced contexts like Sokoto State, inclusive teaching via technology is hampered by poor infrastructure, low digital skills, and a lack of context-specific EdTech strategies. Thus, exploring how educators perceive and utilise EdTech for inclusive teaching is a critical gap that this study aims to address.

Against this backdrop, this study examines educators' empowerment through EdTech integration in Sokoto State's tertiary institutions, focusing on its impact on their skill development and on inclusive pedagogical practices. It examines the extent to which educators have received support for using EdTech to fulfil contemporary pedagogical requirements. This study examines the challenges and opportunities of EdTech implementation, drawing on empirical evidence, as the educational system requires a responsive and inclusive transformation. The research results will guide efforts to develop capacity-building programs and policies alongside institutional learning strategies that promote teaching and learning equity in Nigerian higher education institutions.

Statement of the Problem

Despite the growing global emphasis on digital transformation in education, many lecturers in tertiary institutions in Sokoto State remain resistant to change, rooted in long-standing pedagogical beliefs that favour traditional, lecture-based methods. This reluctance is often fueled by skepticism about whether digital tools enhance learning or disrupt established teaching norms. Some educators fear that embracing technology will diminish their professional identity, making instructional roles seem secondary to automated systems. Others find these tools complicated, so they avoid trying new technology because they lack confidence and motivation. The slow adoption of EdTech continues to limit interactive learning opportunities because educators maintain a traditional mindset that prevents them from adopting student-centred, technology-enhanced education methods that promote engagement and creativity.

Beyond pedagogical resistance, institutional barriers further limit the effective use of technology in instruction, leaving lecturers without the support needed to navigate digital transformation. Many institutions lack structured training programs to equip educators with the skills required to effectively utilise digital tools, reinforcing hesitation and uncertainty. Without strong institutional policies and leadership commitment, lecturers remain isolated in their efforts to explore innovative teaching methods. This situation highlights a pressing need to investigate how pedagogical beliefs, resistance to change, and institutional support intersect to shape educators' engagement with EdTech. Understanding these factors is critical for identifying the barriers and enablers of technology integration and for informing future strategies to promote inclusive, skill-enhancing digital teaching practices in tertiary institutions.

Research Questions

1. **What pedagogical beliefs influence lecturers' resistance to EdTech integration in public tertiary institutions in Sokoto State?**
2. **What institutional support mechanisms are available to lecturers for adopting digital tools in instructional activities?**
3. **What challenges do lecturers face in developing digital skills for inclusive pedagogical practices using EdTech?**

LITERATURE REVIEW

Educational technology integration in teaching and learning presents significant opportunities to enhance instructional delivery while supporting inclusive, skill-based pedagogical practices. The literature review combines existing research findings to establish a comprehensive understanding of EdTech integration, institutional support, and professional development for digital competency. The review uses relevant research to establish a unified understanding of how educational digital transformation should support lecturer professional development and inclusive teaching goals in Sokoto State's resource-limited environment. **To ground this review in established scholarly thinking, we begin with the theoretical framework that underpins this study.**

Theoretical Framework

The Diffusion of Innovation (DOI) theory, developed by Everett Rogers (2003), provides an important lens for understanding how new ideas, technologies, and practices spread within a social system over time. Rogers defined diffusion as the process by which an innovation is communicated through specific channels among the members of a social system. In this situation, adoption occurs through five sequential stages: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). These stages are influenced by individual perceptions and institutional contexts. The DOI theory is particularly useful as a guiding framework for this research, as it explains why some lecturers adopt educational technologies (EdTech) more readily than others and why resistance often emerges despite access to digital tools.

In this research, EdTech tools and platforms are conceptualised as the innovations introduced to lecturers within tertiary institutions in Sokoto State. According to Rogers (2003), five innovation characteristics influence adoption: relative advantage, compatibility, complexity, trialability, and observability. These elements shape how lecturers perceive EdTech's usefulness, its alignment with their teaching philosophy, ease of use, the ability to experiment with it, and visibility of its impact (Dahri et al., 2024). For instance, lecturers may be hesitant to use EdTech if they perceive it as incompatible with established pedagogical beliefs or too complex to implement without adequate support. In situations with limited exposure to successful models, the absence of trialability and observability can further hinder uptake. These constructs directly inform the study's examination of lecturers' beliefs and institutional factors in Sokoto.

Beyond innovation characteristics, DOI also emphasises the importance of communication channels, social systems, and time in shaping the diffusion process. Whether formal (training programs) or informal (peer interaction), communication channels determine how lecturers gain awareness and knowledge of EdTech. Social systems, including the institutional culture, leadership, and policy framework, affect the degree of openness to change (Podgórniak-Krzykacz, 2021). As a dimension of the diffusion process, time highlights that adoption is not instantaneous; instead, lecturers move at varying paces through the adoption stages based on their confidence, institutional climate, and external pressures. In the context of Sokoto's higher education institutions, where systemic support may be weak or fragmented, these elements are central to understanding resistance to adoption.

The DOI framework provides a coherent theoretical grounding for this study's three core research questions. RQ1 explores lecturers' pedagogical beliefs and resistance to change, which align with the DOI's compatibility and complexity constructs. RQ2, which investigates institutional support, links with communication channels and social systems that either enable or constrain EdTech integration. RQ3, addressing digital skill development and inclusive pedagogical practice, relates to trialability and relative advantage, emphasising how experimentation and perceived benefits influence motivation to adopt. DOI offers a practical framework for analysing the interaction among individual perceptions, institutional dynamics, and innovation attributes. It will guide both data interpretation and the design of practical recommendations to advance digital teaching practices in Sokoto's tertiary institutions.

Overview of EdTech Integration in Tertiary Education

The integration of EdTech in tertiary education has become a global imperative, motivated by the need for innovation in teaching and learning. Universities and colleges worldwide are embracing digital tools to promote flexibility, interactive learning, and personalised instruction (Mosquera-Gende, 2023). These technologies include learning management systems, virtual classrooms, collaborative platforms, and content creation tools. Their adoption is intended to shift pedagogical approaches from passive, instruction-based delivery to student-centred models that encourage inquiry, participation, and critical thinking (Dighliya, 2025). EdTech is also used in developed contexts to support distance learning, enhance assessment practices, and provide equitable access to resources. However, the success of such integration depends not only on access to technology but also on educators' willingness and ability to adopt new teaching paradigms (Bizami et al., 2023).

Despite these advancements, the integration of EdTech in many developing countries, including Nigeria, faces several challenges that hinder its complete adoption in higher education. Issues such as inadequate infrastructure, inconsistent internet access, poor electricity supply, and insufficient funding persist as significant barriers (Kennedy, 2025). Moreover, many educators in Nigerian universities lack adequate training in using digital tools effectively, resulting in a superficial or sporadic use of technology in teaching (Nwuke & Yellowe, 2025). In northern states like Sokoto, these issues are compounded by systemic constraints, including weak policy implementation, limited institutional support, and a deep-rooted reliance on traditional teaching methods. As a result, technology adoption often becomes more symbolic than transformative, with lecturers struggling to connect EdTech usage with improved student engagement and inclusive instructional outcomes (Sabri et al., 2024).

In recent years, scholarly discourse has emphasised that successful EdTech integration requires more than hardware provision; it demands strategic planning, ongoing professional development, and institutional commitment to change (Dexter, 2023). Lecturers are more likely to adopt technology when they perceive it as relevant, easy to use, and supported by their institutions. The theoretical foundations of adoption, such as the Diffusion of Innovations, suggest that factors such as relative advantage, compatibility with existing beliefs, and social influence play critical roles in shaping adoption (Rogers, 2003). This highlights the need for an extensive exploration of how educators' pedagogical orientations, training experiences, and organisational environment affect their engagement with EdTech. Understanding these dynamics is vital for promoting inclusive, skill-oriented education that meets the growing demands of Nigeria's tertiary institutions.

Pedagogical Beliefs and Resistance to Change

Pedagogical beliefs significantly shape how educators perceive and engage with educational innovations, including digital technologies. According to González-Pérez and Ramírez-Montoya (2022), Educators tend to interpret new instructional practices through the lens of their established teaching and learning philosophies, which can influence how openly such innovations are received. If an educator's core instructional philosophy aligns more with teacher-centred delivery, integrating student-centred EdTech tools may feel misaligned or even threatening. Baglieri (2022) agrees that resistance often stems not from technical incapacity but from an ideological misfit between teachers' beliefs and the collaborative, exploratory nature of most digital tools. Abedi (2024) further argues that unless educators perceive technology as instrumental in achieving their pedagogical goals, they are unlikely to adopt it meaningfully, regardless of institutional pressures or policy directives.

Resistance to change in teaching activities is rarely due to ignorance or laziness; rather, it reflects complex personal and professional concerns. Gaston and Schneider (2023) argue that educational change threatens educators' identities, particularly when it challenges long-standing practices that define their success in the classroom. Similarly, Ly (2024) posits that innovations such as EdTech demand shifts in control, with teachers needing to relinquish their central, authoritative role for more facilitative roles. These transitions are emotionally challenging, especially in environments lacking peer support or professional mentoring. Resistance, therefore, may be a self-protective response to uncertainty rather than outright rejection of innovation (Voci & Karmasin, 2023). The reluctance observed among lecturers in Sokoto State may align with this pattern of identity-based resistance.

The institutional context further reinforces or weakens resistance, depending on how changes are managed. According to Fobert (2024), successful integration of innovation requires not just top-down mandates but deep engagement with educators' beliefs and concerns. **Anariochi and Nwuke** (2024) agree that many Nigerian lecturers are not opposed to technology per se, but rather feel unsupported and ill-prepared for the pedagogical shifts demanded by EdTech. Adopters must perceive a relative advantage before willingly embracing new practices (Rogers, 2003). Therefore, resistance often signals a gap between institutional ambition and individual readiness. Bridging this divide requires more than training; it necessitates a cultural and emotional investment in teacher development.

Institutional Support for EdTech in Education

The successful integration of educational technology in tertiary institutions heavily depends on the strength and quality of institutional support. When universities and colleges provide clear policies, accessible infrastructure, and ongoing training opportunities, lecturers are more likely to adopt and sustain EdTech use in their instructional routines. According to Hasas et al. (2024), institutional culture plays a vital role in shaping educators' willingness to engage with technology. Without a supportive environment, digital tools often remain underutilised, no matter how advanced they may be. The lack of strategic planning, limited leadership engagement, and disjointed ICT policies in many Nigerian institutions promote uncertainty and resistance among educators, particularly in less technologically advanced areas, such as Sokoto State. (Asagba & Oshebor, 2024).

Support from institutional leadership also includes establishing systems that promote collaboration, innovation, and pedagogical experimentation with digital tools. Institutions that cultivate a culture of innovation are more likely to inspire lecturers to explore new teaching strategies supported by EdTech (Rosienkiewicz et al., 2024). This includes establishing incentive systems, recognising digital excellence in teaching, and embedding EdTech use into performance appraisals and curriculum reforms. When educators are made to feel like active contributors in the digital transformation process, rather than passive implementers, their motivation to experiment with and sustain the use of educational technologies increases (Oliveira & Souza, 2022). Conversely, where institutional expectations are unclear or inconsistent, adoption remains superficial, and technology tools are used merely to replicate traditional instruction rather than to transform it.

Furthermore, institutional commitment must include adequate infrastructure and technical support. In Sokoto State, resources are not entirely scarce, but the available ones are often underutilised due to limited training, ineffective usage, and poor maintenance culture (Sanusi, 2022). As a result, lecturers may have access to computers, projectors, or internet facilities but lack the know-how or encouragement to use them optimally for teaching and learning. Heath et al. (2022) emphasise that effective EdTech integration is not just about availability but about ensuring that institutional systems empower educators to use tools purposefully. Strategic investments in maintenance, support units, and accessible digital platforms can help bridge the gap between access and effective application, ensuring that technology makes a meaningful contribution to educational outcomes.

Professional Development for Digital Skills

Developing digital competencies among lecturers is increasingly viewed as vital in higher education, particularly in response to the growing demand for technology-enhanced instruction. As Rofi'I et al. (2023) observe, effective professional development equips lecturers with the tools and confidence to meaningfully integrate EdTech into their teaching. However, digital skill acquisition requires more than one-off training; it involves ongoing, context-sensitive support that addresses educators' specific teaching environments. Many lecturers in resourced, underutilised settings report low exposure to hands-on digital learning experiences, which limits their practical engagement with technology (Babalola & Fakoyede, 2022). Without structured digital literacy programmes that are both accessible and relevant, even well-intentioned educators may struggle to transition from traditional pedagogies to student-centred digital methods.

Sustainable professional development should build technical skills and promote pedagogical innovation and reflective practice. Programmes that combine theoretical insight with experiential learning, such as peer mentoring, coaching, and collaborative design of digital lessons, tend to yield higher levels of adoption and confidence among educators (Carvalho & Santos, 2022). Moreover, aligning digital training initiatives with institutional goals reinforces educators' sense of purpose and ownership. In Nigeria, however, many training sessions remain generic or sporadic, lacking long-term follow-up or assessment mechanisms (Cappelli & Akkari, 2024). Consequently, lecturers are often left to navigate EdTech integration on their own, which reinforces resistance and diminishes the potential impact of educational technologies in achieving inclusive and engaging teaching practices.

An effective professional development framework must also consider the institutional culture and infrastructure in which digital skill-building occurs. When universities provide adequate time, recognition, and resources for digital learning, lecturers are more likely to experiment and innovate their instructional approaches (Alenezi, 2023). Unfortunately, lecturers in Nigeria frequently encounter logistical challenges, including unstable internet connectivity, limited access to devices, and a lack of dedicated ICT support units (Yusuf & Ibrahim, 2024). These environmental constraints make even the most well-designed training difficult to implement. Therefore, the success of digital skill development hinges not only on training content but also on the broader institutional network that empowers lecturers to apply new skills meaningfully.

Digital Inclusion and Inclusive Pedagogical Practices

Higher education institutions should provide equal access to digital resources and the technology skills that enable students to succeed in learning environments. Achieving digital inclusion in tertiary institutions requires equal opportunities for students from all backgrounds to benefit from technology-based learning (Gottschalk & Weise, 2023). Students in Sokoto State face digital exclusion due to unreliable power supply and insufficient internet access, as well as unaffordable devices that hinder their learning opportunities (Mahmud & Abbas, 2024). Inclusive education, by its nature, welcomes every learner, but digital inequalities frequently make learning more challenging for some students. Schools need to take purposeful action to establish connections between technological infrastructure and cost-effective EdTech solutions which meet specific educational needs.

Inclusive pedagogical practices require teaching methods that accommodate learners' differences and diverse backgrounds. Digital tools enable teachers to develop personalised educational approaches through adaptive learning support systems while providing multi-form content and instruction at varied difficulty levels (Yuanda, 2024). Students who are deaf or hard of hearing, for example, benefit from captioned videos, while students with visual impairments benefit from screen readers. The successful implementation of inclusive EdTech solutions requires educators to possess both digital competence and knowledge about inclusive teaching methods. Addy et al. (2023) state that instructors need proper training before they can use technology effectively for purposes beyond exclusionary practices. Nigerian lecturers generally lack familiarity with digital accessibility standards, which restricts their ability to build inclusive learning spaces. The practice of inclusive pedagogy needs specific inclusion within digital skills training programs.

True digital inclusion requires an understanding of learners' economic, social, and cultural contexts, as well as their specific needs. Students in Sokoto State often lack essential digital literacy skills due to their limited experience with digital technologies. The teaching of digital content requires pedagogies that introduce learning steps in a supportive manner without expecting students to possess prior digital skills (Rapanta et al., 2021). Educational institutions need to adopt teaching methods that utilise material relevant to students' daily lives. The lack of cultural understanding makes EdTech tools less effective, even when they possess excellent features. According to Ackah-Jnr et al. (2025), inclusive practice in African contexts must base its decisions on local needs rather than efficiency, while showing empathy. Inclusive digital education represents a teaching methodology which requires instructors to develop learning methods that ensure all students feel included while actively participating and achieving academic success.

METHODOLOGY

This study adopted a descriptive survey research design to investigate educators' perceptions of EdTech integration for skill development and inclusive pedagogy in public universities across Sokoto State. This design was appropriate as it enabled the researcher to collect data that describes the current views, practices, and experiences of the target population in a systematic and quantifiable manner. Given the scope and distribution of respondents, structured questionnaires were considered suitable for collecting relevant information. As noted by Wang et al. (2019), descriptive survey research involves drawing data from a representative sample to make generalisations about the broader population. The study employed a quantitative approach to explore educators' attitudes toward the adoption and effective use of digital tools for the instructional process in tertiary institutions in the State.

The target population for this study comprises all educators across public universities in Sokoto State. Specifically, the research focuses on academic staff from three institutions: University A, B, and C, which have respective staff populations of 1,254, 362, and 193 educators, totalling 1,809 educators. To ensure representativeness and reduce sampling bias, a multi-stage sampling technique was employed. The sample size was determined using the sample size determination table by Research Advisors (2006), which recommends a sample of 346 respondents for a population of 1,809. In the first stage, proportionate stratified sampling was used to allocate the sample by university size. Accordingly, 240 educators were selected from University A, 69 from University B, and 37 from University C. In the second stage, simple random sampling was used within each stratum to select participants, ensuring each educator had an equal chance of being selected. This method enhances the generalizability of the findings across the public university system in Sokoto State.

The primary instrument used for data collection in this study is the Educational Technology Integration Questionnaire (ETIQ), a researcher-developed tool designed to assess educators' perspectives on the integration of EdTech in public universities in Sokoto State. The questionnaire is structured using a four-point Likert scale and is divided into four sections, labelled A to D. Section A captures respondents' demographic information, while Sections B, C, and D focus on key constructs of the study: Pedagogical Beliefs and Resistance to Change, Institutional Support for EdTech Integration, and Challenges Related to Professional Development for Digital Skills, respectively. Each item on the Likert scale allows respondents to express their level of agreement, ranging from Strongly Disagree (SD = 1) to Strongly Agree (SA = 4). This structure facilitates standardised responses, allowing for quantifiable analysis of educators' views and experiences with technology-enhanced teaching activities. The ETIQ is designed to provide reliable and comprehensive data aligned with the study's research questions.

The instrument used in this study, the ETIQ, underwent a thorough validation process to ensure its relevance and alignment with the study's objectives. The questionnaire was reviewed by experts in educational research and measurement, who assessed each item for clarity, relevance, and alignment with the key constructs under investigation. The initial version of the ETIQ comprised thirty-six items across various sections. Following expert feedback, items that were found to be ambiguous, redundant, or misaligned with the study's focus were revised or eliminated. This review process ensured that the final instrument accurately captured the constructs of pedagogical beliefs, institutional support, and professional development related to digital skills. As a result, the instrument was judged to have achieved strong face, content, construct, and criterion validity and was deemed suitable for collecting accurate and meaningful data for this research.

To establish the reliability of the ETIQ, a pilot study was conducted using a sample of forty educators randomly selected from Shehu Shagari College of Education in Sokoto. The aim was to determine the instrument's internal consistency. The split-half reliability method was employed, in which the questionnaire items were divided into two halves, and the correlation between the two sets of scores was computed. The Spearman-Brown prophecy formula was then applied to adjust the split-half correlation, yielding a Spearman-Brown coefficient of 0.864. This high coefficient indicates strong internal consistency, suggesting that the items reliably measure the intended constructs. According to Octafia et al. (2020), a reliability coefficient closer to 1.0 signifies stronger consistency and dependability of an instrument, while a coefficient near 0 indicates weaker reliability. The pilot study's outcome, therefore, confirms that the ETIQ is a reliable instrument for assessing educators' perceptions of EdTech integration, pedagogical beliefs, institutional support, and digital skills development.

The data collected were analysed using the Statistical Package for the Social Sciences (SPSS). To describe the demographic characteristics of the respondents, Cross-tabulation was used to help identify whether certain challenges are more prevalent among, for example, older versus younger lecturers or male versus female respondents. Descriptive statistics, specifically the mean and standard deviation, were used to answer the research questions regarding pedagogical beliefs, institutional support, and professional development for digital skills. Each questionnaire item was evaluated using these statistical indicators to gauge patterns in respondents' views. A weighted mean served as the benchmark for interpretation: responses below the weighted mean reflected lower agreement, indicating areas needing improvement, while scores above the weighted mean indicated more favourable perceptions. Out of the 355 questionnaires distributed, 344 were correctly completed and used for analysis. Four responses were invalid, while seven were not returned.

RESULTS

Demographic Characteristics

The section below provides a comprehensive overview of respondents' demographic characteristics, focusing on variables such as gender and age distributions. Understanding these demographic patterns provides essential context for interpreting the study's findings. It can inform institutional planning, policy formulation, and the design of support systems tailored to different lecturer groups within tertiary institutions, as presented in Table 1.

Table 1: Demographic Characteristics (Gender * Age Crosstabulation)

			Age				
			31-40	41-50	51-60	61 and Above	Total
Gender	Male	Count	84	93	53	41	271
		% within Gender	31.0%	34.3%	19.6%	15.1%	100.0%
		% within Age	81.6%	77.5%	77.9%	77.4%	78.8%
	Female	Count	19	27	15	12	73
		% within Gender	26.0%	37.0%	20.5%	16.4%	100.0%
		% within Age	18.4%	22.5%	22.1%	22.6%	21.2%
Total		Count	103	120	68	53	344
		% within Gender	29.9%	34.9%	19.8%	15.4%	100.0%
		% within Age	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Field Survey, 2025.

The cross-tabulation of gender and age among the 344 respondents shows that male lecturers dominated across all age groups, accounting for 78.8% of the total sample. The highest proportion of male respondents was in the 41-50 age group (34.3%), followed by the 31-40 age group (31.0%), the 51-60 age group (19.6%), and finally the 61 and above age group (15.1%). Female respondents made up 21.2% of the total sample, with their highest representation also in the 41-50 age group (37.0%), followed by 31-40 (26.0%), and then 51-60 (20.5%), and finally, the 61 and above age group (16.4%). This pattern suggests that both male and female participation peaks in the 41-50 age bracket, indicating this group may be more active or accessible in academic roles. This demographic pattern may have implications for understanding the prevalence of digital adoption challenges, as age and gender appear to influence the levels of exposure, support, and readiness for EdTech integration.

Descriptive Analysis

This section presents the table containing all the items designed to address the first research question on pedagogical beliefs and resistance to EdTech. Descriptive statistics, particularly the mean scores, were used to analyse the responses, as displayed in Table 2.

Table 2: Pedagogical Beliefs and Resistance to EdTech (n = 344)

S/No	Statement	N	Mean	Std. Deviation	Remark
1	I believe traditional lecture methods are more effective than digital tools for delivering content	344	2.4244	1.03585	High
2	I feel that adopting technology may reduce the value of my instructional expertise	344	2.3953	.99888	Low
3	I am concerned that students rely too much on technology instead of developing critical thinking	344	2.3721	1.00200	Low
4	I find that EdTech tools disrupt my teaching flow and class control	344	2.3721	.96946	Low
5	I prefer to stick with the methods I was trained with rather than explore digital innovations	344	2.3837	1.02070	Low
6	I believe that integrating technology requires too much effort for little gain	344	2.4593	1.05453	High
7	I feel anxious when asked to use unfamiliar digital tools in teaching	344	2.4302	.99902	High
8	I believe face-to-face interaction cannot be effectively replicated through technology	344	2.3110	1.04661	Low
9	I avoid EdTech tools because they often complicate simple teaching processes	344	2.4709	1.02691	High
10	I am uncertain about how EdTech aligns with my personal teaching philosophy	344	2.4680	1.04372	High
	Weighted Average			**2.41**	

Source: Field Survey, 2025.

The analysis of lecturers' pedagogical beliefs and resistance to EdTech in tertiary institutions in Sokoto State reveals a moderately cautious stance toward digital integration. As shown in Table 2, the overall weighted mean score of 2.41 suggests that resistance remains moderate rather than deeply entrenched. Items with mean scores above this threshold indicated stronger expressions of resistance or scepticism toward EdTech. Respondents showed higher agreement with statements suggesting emotional or practical barriers to digital adoption, such as anxiety toward unfamiliar tools (M = 2.43), beliefs that technology complicates teaching (M = 2.47), and concerns about the effort-to-benefit ratio (M = 2.46). Conversely, lower mean scores were recorded for items reflecting passive resistance or

philosophical disagreement, such as discomfort with changing teaching methods or doubts about the alignment of EdTech with instructional values. These findings reveal a moderate yet significant pattern of resistance, rooted in both affective and experiential factors.

This section presents a table outlining the items developed to address the second research question on institutional support for EdTech integration. Descriptive statistics, particularly the mean scores, were used to analyse the responses, as shown in Table 3.

Table 3: Institutional Support for EdTech Adoption (n = 344)

S/No	Statement	N	Mean	Std. Deviation	Remark
1	My institution frequently organises workshops and seminars on digital literacy	344	2.4651	.95004	Low
2	Technical support is available when I encounter problems with EdTech tools	344	2.6395	.97685	High
3	The university has a clear policy promoting the integration of EdTech in instruction	344	2.5349	.96827	Low
4	My institution provides reliable internet access to support digital teaching	344	2.5058	.97189	Low
5	I receive adequate guidance on selecting appropriate digital tools for teaching	344	2.5610	.96998	High
6	There is a well-equipped ICT unit that supports teaching innovations	344	2.5610	.97896	High
7	Leadership at my university actively encourages digital transformation	344	2.5727	1.00172	High
8	There is collaboration among departments to share digital teaching strategies	344	2.6134	.95919	High
9	My institution has developed a digital teaching framework aligned with national policies	344	2.5523	.97349	Moderate
10	My university's investment in EdTech reflects a long-term digital teaching strategy	344	2.4826	1.01000	Low
	Weighted Average			**2.55**	

Source: Field Survey, 2025.

The analysis of institutional support for EdTech adoption in tertiary institutions in Sokoto State reveals a generally modest yet encouraging level of backing for digital teaching initiatives. As reflected in Table 3, the weighted average of 2.55 suggests that overall institutional support is slightly above average but not uniformly strong. Several items scored above the weighted mean, indicating areas where lecturers perceive more active support, such as departmental collaboration on digital strategies (M = 2.61), leadership encouragement of digital transformation (M = 2.57), and the presence of ICT units supporting innovation (M = 2.56). Technical support availability (M = 2.64) also emerged as a relatively strong. However, items such as internet reliability (M = 2.51), EdTech policy clarity (M = 2.53), and investment in long-term digital strategies (M = 2.48) fell below the average, indicating inconsistent institutional backing and areas requiring strategic improvement.

This section presents a table outlining the items designed to address the third research question on challenges in digital skill development. Descriptive statistical analysis, particularly the use of mean scores, was applied to interpret the responses, as shown in Table 4.

Table 4: Digital Skill Development Challenges for Inclusive EdTech Utilisation (n = 344)

S/No	Statement	N	Mean	Std. Deviation	Remark
1	I lack adequate time to learn how to use digital tools effectively	344	2.7703	.93031	High
2	My workload prevents me from engaging in professional development for EdTech	344	2.7442	.92501	Low
3	The training I have received does not match the real-world classroom challenges I face.	344	2.7703	.97917	High
4	I struggle to stay updated with rapidly changing EdTech tools	344	2.7936	.93887	High
5	I find it challenging to integrate EdTech into inclusive teaching for diverse learners	344	2.7674	.94050	High
6	I face challenges in integrating digital tools with existing curriculum standards	344	2.7384	.93281	Low
7	Internet instability disrupts my efforts to adopt digital tools in class	344	2.7558	.95906	Low
8	Limited availability of devices affects my confidence in EdTech integration	344	2.7703	.99394	High
9	I do not receive feedback or support after training sessions	344	2.7645	.96578	Moderate
10	Many EdTech tools are introduced without proper follow-up or hands-on training	344	2.7384	.96355	Low
	Weighted Average			**2.76**	

Source: Field Survey, 2025.

The analysis of digital skill development challenges among lecturers highlights a generally high level of difficulty in keeping pace with EdTech demands, as indicated by the weighted average of 2.76 in Table 4. Several challenges exceeded this average, revealing significant concerns, such as keeping up with rapidly evolving EdTech tools (M = 2.79), limited access to digital devices (M = 2.77), inadequate time for learning new tools (M = 2.77), and gaps between training content and classroom realities (M = 2.77). These scores suggest that lecturers feel overwhelmed by both structural and pedagogical demands. Items falling just below the average, such as difficulties with curriculum integration (M = 2.74) and a lack of post-training follow-up (M = 2.76), indicate persistent though slightly less intense issues. These findings reflect genuine concerns about capacity and support, highlighting the need for better-aligned training, ongoing mentorship, and hands-on, inclusive professional development.

DISCUSSION OF FINDINGS

The research findings offer significant contributions to the existing body of knowledge on integrating educational technology to enhance skill development and promote inclusive pedagogical practices in tertiary institutions within Sokoto State. The discussion is structured to align with the research objectives and guiding questions, ensuring a thorough and insightful analysis of the subject matter.

The findings on lecturers' pedagogical beliefs and resistance to EdTech in Sokoto State align with scholarly perspectives that link instructional resistance to ingrained teaching philosophies. Respondents expressed greater concern over practical and emotional challenges, such as discomfort with unfamiliar tools and the perception that technology complicates instruction, rather than outright ideological rejection. This supports González-Pérez and Ramírez-Montoya's (2022) view that educators interpret innovation through existing pedagogical lenses, and that resistance often emerges when these innovations appear misaligned with deeply rooted teaching practices. The findings suggest that while resistance is not extreme, it reflects an underlying tension between traditional teacher-centred beliefs and the collaborative, student-focused demands of EdTech, as Baglieri (2022) and Abedi (2024) have similarly observed.

Moreover, the moderate resistance pattern highlights that reluctance towards EdTech may stem more from identity-related and environmental challenges than from a rejection of technology itself. Gaston and Schneider (2023) argue that educators resist innovations when they feel their professional identity is at stake, a sentiment likely reflected in the respondents' concerns about losing instructional control. Similarly, Ly (2024) emphasises the emotional challenges of transitioning from an authoritative to a facilitative teaching role, particularly in institutions lacking formal mentoring structures. These insights resonate with Voci and Karmasin's (2023) framing of resistance as a self-protective response rather than mere defiance. While existing studies offer valuable perspectives, they often overlook the sociocultural dynamics unique to Northern Nigeria. This study adds depth by contextualising resistance within Sokoto's tertiary institutions, highlighting how institutional neglect and inadequate professional development contribute to educators' reluctance. Thus, this research not only supports existing frameworks but expands them to accommodate region-specific pedagogical realities.

The findings on institutional support for EdTech adoption in Sokoto State reveal a moderately positive perception among lecturers, as shown by the overall weighted mean of 2.55. Respondents expressed greater agreement with items reflecting the availability of technical support, collaborative departmental practices, and administrative encouragement. This suggests that while there are promising indicators of support, the system is not yet fully optimised. These findings align with those of Hasas et al. (2024), who argue that institutional culture influences educators' engagement with technology. Without a coherent support structure, clear policies, strategic planning, and responsive leadership, lecturers may not fully adopt or sustain digital teaching practices, even when infrastructure is available.

Additionally, lower mean ratings on internet access and digital literacy workshops reveal existing institutional gaps that limit meaningful engagement with EdTech. This supports Asagba and Oshebor's (2024) observation that infrastructural inadequacy and inconsistent policy implementation can breed uncertainty, leading to superficial use of technology. The moderate perceptions reported may reflect institutions that offer tools without adequate follow-up, training, or performance incentives, a point raised by Rosienkiewicz et al. (2024) and Oliveira & Souza (2022). These findings suggest that while some foundations for digital transformation exist, EdTech is not yet embedded into the pedagogical culture. This study examines the lived experiences of lecturers in resource-constrained public institutions, highlighting systemic barriers to EdTech implementation in Northern Nigeria, including inadequate training, vague digital policies, and underutilised infrastructure. It offers a grounded perspective on EdTech challenges in Northern Nigeria, an area that has been largely overlooked in prior research.

The findings on digital skills development challenges reveal that lecturers in Sokoto State face significant barriers to the effective adoption of EdTech tools. As indicated by the weighted mean score of 2.76, respondents reported strong agreement with challenges such as a lack of time, a mismatch between training content and real classroom needs, and difficulties keeping pace with evolving technologies. These findings support Rofi'I et al.'s (2023) assertion that one-off trainings are insufficient and that ongoing, context-specific support is vital for sustainable digital integration. However, unlike earlier studies, which generalise about professional development needs across higher education, this research uncovers how infrastructural issues, such as poor connectivity and limited access to devices, intensify these challenges in Northern Nigeria, an underrepresented region in the existing literature that demands more localised inquiry.

Moreover, the analysis underscores a gap between digital training and inclusive pedagogical practice. Respondents highlighted difficulties in adapting EdTech tools for diverse learners, a view that resonates with Addy et al.'s (2023) view that inclusive teaching requires more than basic digital proficiency; it demands knowledge of accessibility standards and student-centred design. While prior studies emphasise pedagogical innovation and institutional alignment, they often overlook how deeply sociocultural and infrastructural conditions shape EdTech adoption in marginal contexts. This study addresses that gap by focusing on the real-world challenges educators in Sokoto face, offering insights that expand the scope of digital inclusion discourse. Unlike generic policy recommendations, this research draws from grounded local realities, revealing how the absence of personalised support limits lecturers' ability to deliver truly inclusive digital education.

CONCLUSION

This study examined the influence of pedagogical beliefs, institutional support, and challenges in digital skill development on lecturers' engagement with EdTech in public tertiary institutions in Sokoto State. The findings demonstrate that resistance to EdTech among lecturers is moderate and shaped mainly by emotional and experiential concerns. Rather than rejecting technology outright, many lecturers reported unease with unfamiliar tools and expressed doubts about the practicality of integrating EdTech into their existing teaching methods. These concerns

reflect the tension between traditional, teacher-centred pedagogical beliefs and the collaborative, learner-focused nature of most digital technologies. Without targeted, context-specific professional development, many lecturers remain uncertain about how to adapt their teaching practices to align with digital innovations. Institutional support has emerged as a crucial factor influencing the adoption of technology. While some institutions possess basic digital infrastructure, their impact is diminished by unclear implementation policies, inconsistent training, and limited administrative involvement. The lack of strategic planning and consistent guidance creates an environment in which digital tools are either underused or used in ways that merely replicate traditional instruction rather than enhance learning. Moreover, existing professional development programmes tend to be generic and often fail to address the inclusive pedagogical needs necessary for effective EdTech utilisation. Consequently, many lecturers are ill-equipped to design or deliver instruction that meets their students' varied learning needs.

Recommendations

Based on the findings of this research, the following recommendations are proposed to enhance lecturers' engagement with EdTech in public universities in Sokoto State:

Reorient Professional Development Toward Context-Specific Pedagogical Needs: To address lecturers' pedagogical resistance, professional development should be designed to align with classroom realities and lecturers' beliefs about teaching and learning. Training must go beyond one-off workshops and offer ongoing, peer-supported programmes that combine technical skill-building with pedagogical reflection and inclusive strategies. However, a major challenge is low participation due to heavy workloads, a lack of motivation, or perceived irrelevance. To overcome this, institutions should embed participation in performance evaluations, offer workload reductions, and make training sessions flexible and relevant to lecturers' subject areas and student demographics.

Establish Clear Institutional Policies and Visible Administrative Support: Institutional support must be strengthened through the development and enforcement of clear digital integration policies backed by visible leadership commitment. Lecturers need to see that their institutions value innovation by recognising and rewarding efforts to integrate EdTech. The primary challenge is administrative inertia, often resulting from competing priorities or limited leadership buy-in. This can be addressed by forming cross-functional EdTech implementation committees that include representatives from educators, ICT staff, and administrators to ensure shared ownership and continuous monitoring of digital teaching goals.

Enhance Infrastructure and Access to Supportive Technical Environments: To reduce emotional and practical resistance to EdTech, institutions must provide stable infrastructure, including reliable internet, consistent power, functioning devices, and access to real-time technical support. Despite the facilities available in some institutions, poor maintenance and limited accessibility discourage use. A key challenge is inadequate funding and a weak culture of resource utilisation. This can be addressed by developing maintenance schedules, training ICT personnel, and properly utilising government grants or partnerships with EdTech firms to fund and sustain infrastructure upgrades.

Embed Inclusive Digital Practices in Skill Development Initiatives: Professional development should explicitly incorporate modules on inclusive teaching methods using EdTech, empowering lecturers to create content that supports all learners, particularly those with disabilities or limited digital exposure. The challenge lies in educators' pervasive lack of awareness of digital accessibility standards. This gap can be bridged by integrating inclusive design principles into all digital training and by encouraging educators to assess their course materials through a lens of diversity, accessibility, and equity, bolstered by digital teaching audits or peer-review systems.

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EVALUATING ACADEMIC STAFF AWARENESS AND PREPAREDNESS FOR AI INTEGRATION IN 21ST CENTURY TEACHING AT FEDERAL COLLEGE OF EDUCATION, ILAWE-EKITI, NIGERIA

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Abstract

The application of Artificial Intelligence (AI) in higher education is transforming teaching methods, learning engagement, and organizational efficiency. However the familiarity, preparedness, and capability of academic staff in Nigerian Colleges of Education regarding AI remain largely unexplored. This study assessed the awareness and readiness of staff at the Federal College of Education, Ilawe-Ekiti, Ekiti State, Nigeria, for integrating AI into 21st-century pedagogy. Employing a descriptive survey design, data were gathered from 45 staff members through a guided questionnaire addressing demographics, awareness, readiness, and specific AI tools. Quantitative data were analyzed using descriptive statistics, t-tests, ANOVA, Pearson's correlation, Chi-square tests, and regression analysis. Results indicated a high mean score for general awareness ($M = 4.0$) and a lower score for preparedness ($M = 3.9$), with a significant correlation between the two ($r = .536$, $p < .001$). The most commonly used AI tools included ChatGPT (88.6%), Grammarly (70.5%), and Canva AI (43.2%), while tools like Kai (2.3%) and DeepSeek (4.5%) were minimally utilized. Regression analysis showed that awareness was the strongest predictor of preparedness ($\beta = .586$, $p < 0.001$), while demographic factors like gender, age, and academic rank had no significant impact. Chi-square analysis revealed a significant association between high awareness and preparedness ($\chi^2(1) = 7.515$, $p = 0.006$). These findings underscore the necessity for institutional support, including AI-focused training and policies, to enhance AI integration in educational settings. This study contributes empirical insights into AI readiness in Nigerian education.

Keywords: *Artificial Intelligence, teacher readiness, awareness, preparedness, higher education, Nigerian Colleges of Education*

Introduction

Emerging technologies are changing how education is delivered, accessed, and evaluated in the current information economy. One of the most revolutionary technologies to change the education sector is artificial intelligence (AI), which allows machines to simulate cognitive functions including learning, reasoning, and problem-solving. AI in education has evolved from experimental pilot projects to practical, deployable solutions that improve teaching and learning. With tools that allow adaptive learning pathways, enable automated marking, personalize feedback, and offer predictive analysis of learner performance, artificial intelligence is transforming pedagogy on a global scale (Chounta, Holmes, Persson & Wasson, 2022).

With tools like AI-supported tutoring, automated essay marking, and intelligent material distribution, universities in technologically sophisticated nations have been at the forefront of the adoption of AI in higher education. Adoption of this kind is consistent with the Fourth Industrial Revolution (4IR), which requires educators to change into new teaching methods that equip students for technologically advanced and active occupations. ChatGPT, Grammarly, Google Bard, and Canva AI are examples of AI technologies that give academic staff the ability to deliver outstanding, engaging, and data-driven classes and free time for higher-order instructional work that cannot be automated.

Nigeria and other African nations have not yet incorporated AI into their educational systems. There is no degree of integration at the classroom level, despite the fact that several colleges and training institutions have looked into AI-powered systems for administration and research. Infrastructure-related issues including inadequate internet connectivity, a lack of modern computing resources, and a lack of institutional support for professional training are the main causes of all of this. Furthermore, there is a skills gap between technology access and practical usage in classrooms because most teachers lack professional certification in the use of AI in pedagogy (Okonkwo & Ade-Ibijola, 2021).

As the primary center for teacher preparation, the Federal Colleges of Education (FCEs) play a crucial role in Nigeria's educational system. To link Nigeria's teacher education system to international 21st-century teaching best practices, these institutions must promote innovative pedagogy. The institutions will probably lag behind in providing teachers with the necessary training to educate students for the digital age if there is no factual data on academic staff awareness and preparedness to incorporate AI.

Statement of the Problem

Even though AI's revolutionary potential in education is widely acknowledged, its integration into Nigerian teacher education institutions has been sluggish and dispersed. Even while academic staff members may have heard of artificial intelligence (AI) or come across AI-enabled products, awareness does not always equate to readiness for successful application in the classroom. Teachers frequently lack the skills needed to effectively incorporate AI into lesson preparation, instructional delivery, and student assessment.

This problem is exacerbated by institutional obstacles. The majority of Federal Colleges of Education lack explicit rules, training programs, or technical support systems for the application of AI, even in cases where there is some awareness of the technology. AI integration in such a situation is dependent on individual conduct rather than a well-thought-out institutional approach due to institutional flaws. As a result, the potential of AI to boost student engagement, enhance instruction, and reduce administrative processes remains unexplored.

The lack of empirical research evaluating academic staff members' preparedness to adopt AI at the Federal College of Education, Ilawe-Ekiti creates a knowledge gap that hinders informed decision-making. It would be challenging for administrators and legislators to develop effective capacity-building programs without trustworthy data on the degree of staff awareness, readiness, and use of AI tools. This gap needs to be closed in order to promote the incorporation of AI and familiarize the institution with contemporary pedagogical approaches.

Objectives of the Study

The main aim of this study is to evaluate the awareness and preparedness of academic staff for AI integration in 21st-century teaching at the Federal College of Education, Ilawe-Ekiti, Ekiti State.
The specific objectives were to:

1. Assess the level of awareness of AI concepts and tools among academic staff.
2. Determine the level of preparedness for AI integration in teaching.

3. Identify the AI tools most commonly used by staff.
4. Examine the relationship between awareness and preparedness.
5. Investigate the influence of demographic factors on AI readiness.

Research Questions

1. What is the level of awareness of AI concepts and tools among academic staff at FCE Ilawe-Ekiti?
2. What is the level of preparedness for AI integration in teaching?
3. Which AI tools are most commonly used by academic staff?
4. Is there a significant relationship between awareness and preparedness for AI integration?
5. Do demographic factors such as gender, age, academic rank, and teaching experience significantly influence AI readiness?

Review of Relevant Literature

In education, artificial intelligence (AI) is broadly characterized as the application of computer systems that are able to carry out tasks like learning, problem-solving, reasoning, and language interpretation that would normally need human intellect (Russell & Norvig, 2021). By enabling adaptive learning paths, automating testing, and offering tailored feedback, artificial intelligence (AI) technologies are used in education to improve the teaching-learning process. AI's introduction into classrooms signifies a paradigm shift away from traditional pedagogies and toward student-centered, technology-facilitated approaches. The shift is in line with the global push for 21st-century skills, which emphasize the importance of critical thinking, creativity, teamwork, and technical literacy (UNESCO, 2021).

The earliest intelligent tutoring systems that replicate elements of human tutoring were developed in the 1970s and 1980s, marking the beginning of the use of AI in education (Woolf, 2021). AI now has characteristics to handle complex datasets, contextual subtleties in human speech, and even real-time tutorial support because to developments in machine learning (ML) and natural language processing (NLP). Nowadays, programs like ChatGPT, Grammarly, and Khanmigo are well-established as technologies that enable various facets of academic work, from content production to the provision of experiential learning.

Aside from technical applications, the use of AI in education is increasingly in line with the idea of human–AI collaboration, in which AI supports instructors rather than replaces them (Luckin et al., 2016). This vision emphasizes how human capacities for empathy, ethical reasoning, and contextual judgment complement AI's advantages in data processing, scale, and personalization. As a result, the conception of AI in education encompasses not just its technical aspects but also the institutional, ethical, and pedagogical frameworks that support its ideal implementation.

Awareness, in this study's context, refers to educators' knowledge, understanding, and perception of AI concepts and applications relevant to teaching and learning. This includes familiarity with AI-related terminology, recognition of existing AI tools, and comprehension of AI's potential benefits and limitations. Zawacki-Richter et al. (2019) stress that awareness is the first critical step in the technology adoption lifecycle without sufficient awareness, the likelihood of technology integration is significantly reduced.

There are signs that educators' awareness of AI varies greatly by geography, subject, and institutional capacity worldwide. Teachers in advanced economies are much more likely to learn about AI tools through staff development meetings, conferences, and training. These experiences go beyond simple knowledge and raise their awareness of AI as a beneficial tool for education. Most underdeveloped countries, including Nigeria, have relatively low levels of awareness. Research has indicated that while educators may comprehend some aspects of AI, their knowledge may be superficial and insufficient to enable them to make informed adoption decisions (Okonkwo & Ade-Ibijola, 2021).

Disparities based on discipline and generational differences also contribute to the AI awareness gap. While older or non-STEM teachers could be less exposed, younger teachers—especially those in tech-focused departments—will be

more aware. Furthermore, awareness grows slowly in the absence of organizational initiatives like workshops, policy statements, or pilot programs, with differences in technology use predominating amongst departments and schools.

The ability and readiness of educators to successfully incorporate AI tools into their teaching practices is known as preparedness. Technical proficiency, instructional adaptability, institutional support, and the availability of essential infrastructure are only a few of its many facets. According to Luckin et al. (2016), readiness is a complex concept influenced by both systemic and individual elements rather than a single variable.

Digital literacy, technology self-efficacy, and prior experience with learning innovations all influence an individual's level of preparedness. AI tools are likely to be successfully adopted by educators who are digitally savvy and open to changing their teaching methods. The availability of reliable internet, technical support staff, expenditures for technology purchases, and professional development programs all contribute to institutional preparation. Even highly personally prepared teachers may not be able to effectively deploy AI in the absence of these facilitators.

Mhlanga (2023) observes that although interest in implementing AI is increasing in Nigeria, institutional preparedness is still uneven. Adoption of technology is challenging in most schools and universities due to infrastructure problems including power outages and erratic internet connections. Additionally, training is usually sporadic, which makes it difficult for educators to develop the skills necessary to use AI. The literature on technology adoption has extensively shown the connection between awareness and readiness. Teachers are more willing to investigate available resources, participate in training, and test integration procedures when they are more aware, which can result in greater readiness. Low awareness can therefore stifle readiness and lead to opposition, postponement, or total rejection of new technology (Woolf, 2021).

This association has been supported by empirical research. For example, Holmes et al. (2022) discovered that instructors in universities with AI awareness were significantly better prepared than those without the activities. Awareness eliminates the uncertainty surrounding the integration of new tools and adds a feeling of familiarity. Teachers can more confidently use AI into their lessons when they are aware of both its capabilities and limitations.

The link is especially pertinent in the Nigerian context because the majority of these educators work in settings with shaky institutional support. According to Eze et al. (2023), even in the absence of formal training, instructors at teacher education institutes who had a high level of awareness of AI through self-study or peer-to-peer learning were more likely to be ready to embrace AI. This implies that raising awareness could be a good place to start when it comes to enhancing preparedness in resource-constrained settings.

Over the past few years, there has been a significant increase in the number of AI-based teaching tools accessible. While specialized programs like Khanmigo, TeachFX, and Quillionz provide subject-specific assistance, general-purpose applications like Google Bard, ChatGPT, and Grammarly contain features for content creation, grammatical correction, and brainstorming. Improved lesson planning, automatic marking, analysis of class interactions, and even student-specific learning are all made possible by these tools (Holmes et al., 2019).

For instance, MindsDB and IBM Watson use data to provide insights on student learning and program efficacy, while Canva AI helps create visually appealing instructional materials. Even though they are typically thought of as consumer goods, Google Assistant and Siri can be used in educational activities to quickly look up information or automate some tasks. The range of tools suggests that platforms must be chosen in accordance with institutional requirements, pedagogical goals, and resource accessibility.

However, there are limitations on the use of AI techniques in Nigeria's educational system. Large-scale adoption has been hampered by exorbitant licensing costs, inadequate training to handle the technology, and doubts about AI's legitimacy. Nonetheless, the advantages of using AI technologies to change teaching methods are widely acknowledged, especially in terms of increasing productivity and facilitating personalized learning in large, heterogeneous classrooms.

There are several obstacles to the use of AI in education that cut across institutional, ethical, and technical spheres. Technically speaking, most Nigerian institutions lack adequate infrastructure, which includes unstable power supplies

and inconsistent internet. Inadequate funding for technology, a lack of an explicit AI adoption policy, and a lack of technical support for teachers are examples of institutional issues (Mhlanga, 2023).

Morally, concerns about algorithmic prejudice, data privacy, and the danger of relying too much on AI are still urgent. Schiff (2022) warns that uncontrolled AI deployment may have unanticipated consequences, such as entrenching inequity and reducing human control in important decision-making. These become concerns for educators over how AI affects student agency, academic integrity, and the humanity of pedagogy.

Another obstacle is resistance to change. Some educators worry that AI will damage their reputation as professionals or interfere with traditional teaching methods. In addition to technical training, institutions must undergo a cultural shift that emphasizes AI as a supplementary tool rather than a substitute for human teachers in order to overcome this opposition.

Although AI awareness and preparedness have been extensively studied worldwide, there are still few context-specific studies in Nigerian teacher training institutions. Although awareness is portrayed in the literature as a prerequisite for preparedness, there aren't many experimental investigations that support this in Nigeria. Additionally, prior studies seldom combine qualitative descriptions of the types of AI tools that instructors actually use with quantitative assessments of awareness and preparedness. Through the empirical data of academic staff at the Federal College of Education, Ilawe-Ekiti, this study fills up these research gaps. It provides a count of AI tools in use as well as a thorough assessment of awareness, preparedness, and the relationship between the measures. The results are meant to influence professional development, institutional policy, and public conversation about AI integration in Nigerian higher education.

Methodology

The study evaluated academic staff awareness and readiness for AI integration at the Federal College of Education, Ilawe-Ekiti, using a descriptive survey design. 45 full-time employees with at least a year of teaching experience were purposefully chosen from a pool of 60 lecturers. Although it reduced generalizability and increased potential sampling bias, this sampling strategy guaranteed the inclusion of seasoned and regularly involved lecturers. A structured questionnaire that was created from literature and verified by expert review was used to gather data. High reliability was demonstrated by a pilot test with Cronbach's alpha values greater than 0.80. The researcher personally distributed the questionnaire after receiving ethical permission, guaranteeing anonymity and obtaining a 100% response rate. SPSS version 20 was used to analyze the data. While inferential tests like correlation, chi-square, t-tests, ANOVA, and multiple regression were employed to examine associations and find predictors of preparation, descriptive statistics reported the results. The significance level for all tests was set at 0.05.

Results and Discussion

This chapter presents the results of the statistical analyses conducted to evaluate academic staff awareness and preparedness for integrating artificial intelligence (AI) in 21st-century teaching at the Federal College of Education, Ilawe-Ekiti, Nigeria. The analyses address the research objectives and questions outlined earlier. Data were analyzed using descriptive statistics (frequencies, percentages, means, and standard deviations) as well as inferential statistics (correlation analysis, independent samples t-test, ANOVA, chi-square test, and multiple regression). The results are presented under thematic headings that correspond to the study objectives.

Demographic Characteristics of Respondents

A total of 45 academic staff participated in the study. Table 1 presents the demographic profile of respondents, covering gender, age, academic rank, years of teaching experience, and faculty/school affiliation. The gender

distribution shows that 55.6% of the respondents were male, while 44.4% were female, indicating a relatively balanced representation.

Table 1
Demographic Characteristics of Respondents

S/N	Variable	Category	Frequency	Percent
1	**Gender**	Male	25	55.6
		Female	20	44.4
2	**Age**	20–30 years	10	22.2
		31–40 years	14	31.1
		41–50 years	19	42.2
		Above 50 years	2	4.4
3	**Academic Rank**	Assistant Lecturer	19	42.2
		Lecturer III	16	35.6
		Lecturer II	6	13.3
		Lecturer I	1	2.2
		Senior Lecturer	3	6.7
4	**Years of Teaching Experience**	Less than 5 years	16	35.6
		5–10 years	13	28.9
		11–15 years	6	13.3
		More than 15 years	10	22.2
5	**Faculty/School**	School of Arts & Social Sciences	2	4.4
		School of Sciences	4	8.9
		School of Education	36	80.0
		School of Languages	1	2.2
		Vocational & Technical Education	2	4.4

The age distribution reveals that most participants (42.2%) fell within the 41–50 years bracket, followed by 31.1% in the 31–40 years range. Younger academic staff aged 20–30 years constituted 22.2% of the sample, while only 4.4% were above 50 years. This age spread reflects a relatively mature academic workforce with substantial teaching experience. The years of teaching experience distribution shows that a significant proportion (35.6%) had less than 5 years of experience, while 28.9% had between 5 and 10 years. The School of Education had the largest representation (80.0%), which is expected given the institution's focus as a teacher-training college.

Awareness of AI in Education

Respondents' awareness levels were assessed through multiple Likert-scale items measuring familiarity with AI concepts, knowledge of AI applications in education, and exposure to AI-related training. Table 2 presents the descriptive statistics for each awareness item.

Table 2: *Descriptive Statistics for Awareness Items*

S/N	Statement	N	Min	Max	Mean	Std. Dev.
1	I am familiar with the concept of AI	45	4	5	4.76	0.44
2	I am aware of how AI is used in education globally	44	3	5	4.61	0.58
3	AI can improve teaching effectiveness	43	3	5	4.51	0.59
4	I know AI tools for grading/tutoring/lesson planning	44	2	5	4.02	0.73
5	My institution has introduced AI concepts	44	1	5	2.84	0.96
6	Awareness of AI varies across departments/ages	44	1	5	3.73	1.02

The results indicate high awareness levels for core AI concepts, with the highest mean score recorded for familiarity with AI (M = 4.76, SD = 0.44). However, institutional introduction of AI concepts scored considerably lower (M = 2.84, SD = 0.96), suggesting limited formal sensitization within the college.

Preparedness for AI Integration

Preparedness was measured through items assessing training received, confidence in applying AI, access to resources, willingness to adapt teaching methods, and digital skills adequacy. Table 3 shows the descriptive results.

Table 3: *Descriptive Statistics for Preparedness Items*

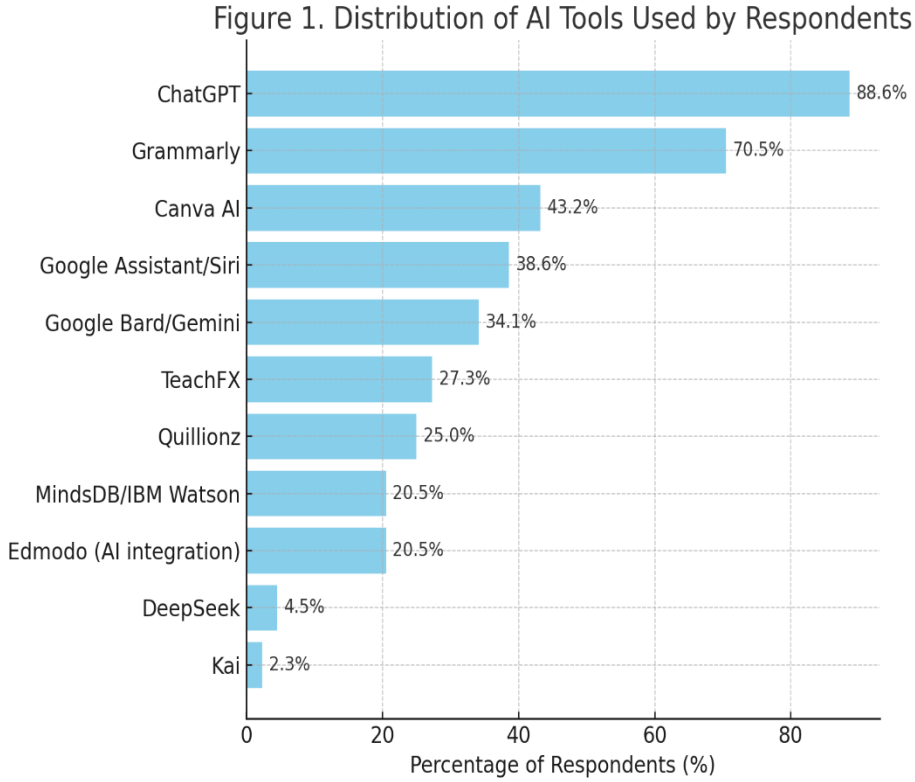
S/N	Statement	N	Min	Max	Mean	Std. Dev.
1	I have received AI training	44	1	5	3.02	1.09
2	I feel confident applying AI in teaching	45	2	5	3.91	0.90
3	I have access to reliable internet	45	1	5	3.89	0.94
4	I am willing to adapt my teaching to AI	45	2	5	4.29	0.79
5	My digital skills are adequate for AI use	45	1	5	3.89	1.09

Although respondents expressed a strong willingness to adapt their teaching to include AI (M = 4.29, SD = 0.79), actual AI training levels were low (M = 3.02, SD = 1.09). This gap highlights the need for capacity-building programs.

4.4 AI Tools Familiarity

Figure 1 presents a visual summary of AI tools that respondents reported using or being familiar with. ChatGPT (88.6%) and Grammarly (70.5%) were the most recognized tools, followed by Canva AI (43.2%) and Google Assistant/Siri (38.6%).

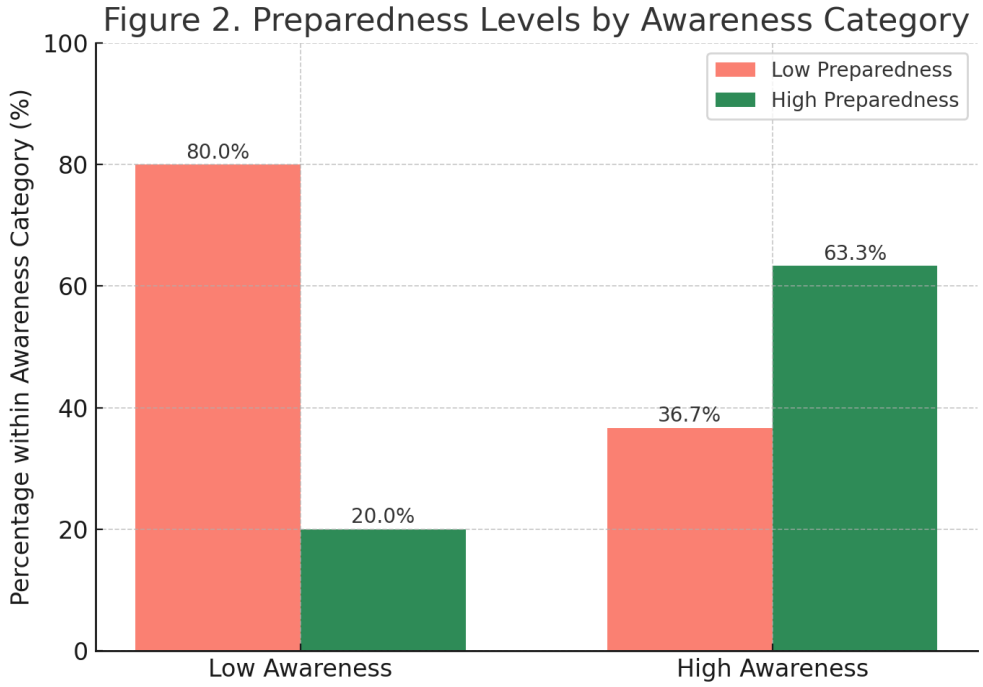
Figure 1: *Familiarity with Various AI Tools Among Aca*



Relationship Between Awareness and Preparedness

Pearson correlation analysis showed a significant positive relationship between awareness and preparedness ($r = .536$, $p < .001$). This indicates that higher awareness levels were associated with higher preparedness levels. The categorization into high and low awareness/preparedness further revealed that 63.3% of those with high awareness also had high preparedness, whereas 80% of those with low awareness had low preparedness (Figure 2).

Figure 2: *Preparedness Levels by Awareness Category*



Inferential Statistics

Table 4
Independent Samples t-Test for Gender Differences in AI Awareness

S/N	Variable	Gender	N	Mean	SD	t(df)	p
1	**Awareness**	Male	25	4.09	0.44	–0.06 (43)	.952
		Female	20	4.10	0.45		

Independent samples t-tests found no significant gender differences in awareness (t(43) = -0.06, p = .952). ANOVA indicated no statistically significant differences in awareness by academic rank (F(4, 40) = 1.07, p = .384) or by faculty/school (F(3, 41) = 2.57, p = .067), although mean differences suggested some variation by age.

Table 5: *Chi-Square Test for Association Between Awareness and Preparedness Categories*

S/N	Test	Value	df	p
1	Pearson Chi-Square	7.515	1	.006
2	Continuity Correction	5.881	1	.015
3	Likelihood Ratio	7.919	1	.005
4	Fisher's Exact Test	—	—	.011

Chi-square tests revealed a significant association between awareness category and preparedness category ($\chi^2(1, N = 45) = 7.515$, $p = .006$), confirming that awareness levels are strongly linked to preparedness outcomes.

Table 6: *Multiple Regression Predicting Preparedness*

S/N	Predictor	B	SE B	β	t	p
	(Constant)	0.952	1.034	—	0.920	.363
1	Awareness	0.811	0.207	.586	3.914	.000
2	Gender	–0.269	0.164	–.222	–1.635	.110
3	Age	–0.108	0.127	–.154	–0.846	.403
4	Academic Rank	–0.042	0.082	–.079	–0.516	.609
5	Years of Teaching Experience	0.104	0.088	.199	1.180	.245
6	Faculty/School	0.049	0.127	.055	0.383	.704

Model Summary: $R^2 = .367$, Adjusted $R^2 = .267$, $F(6, 38) = 3.678$, $p = .006$.

Multiple regression analysis identified awareness as the strongest predictor of preparedness ($\beta = .586$, $p < .001$), while gender, age, academic rank, years of teaching experience, and faculty were not significant predictors. The overall model explained 36.7% of the variance in preparedness ($R^2 = .367$, $F(6, 38) = 3.678$, $p = .006$).

Summary of Findings

The implication of this research is that the academic staff within the Federal College of Education, Ilawe-Ekiti has a reasonably high level of consciousness regarding artificial intelligence (AI), particularly with such popular tools like ChatGPT and Grammarly. This would suggest that certain AI tools have permeated academic consciousness insofar as they are openly recognized within the public domain and convenient to apply. But awareness dropped precipitously for specialist AI devices particularly aimed at education, such as Khanmigo and Quillionz, pointing to pedagogically specialist technology exposure gaps.

Readiness in confidence, capacity to adapt, and access to resources was uneven. Staff were highly keen to incorporate AI into practice on the plus side, showing a good attitude towards technological change. In contrast, readiness was compromised by limited institutional training and inconsistent access to resources directly focused on AI. This "readiness gap" recognizes the difference between wanting to implement technology and being in a place to do so effectively.

The statistical regression further revealed that awareness became a strong predictor of preparedness ($\beta = .586$, $p < .001$), signifying the role of knowledge and acquaintance as precursors to practice. Interestingly, demographic factors of gender, age, academic rank, and teaching experience did not prove to be predictive factors for awareness and preparedness, which suggests that one's willingness to utilize AI is more a function of exposure and organizational support than individual qualities.

Education Awareness of AI

The very high awareness levels for ChatGPT (88.6%) and Grammarly (70.5%) are in accord with more general patterns in AI uptake, where tools that have a mass worldwide user base find it easily to enter the hearts of educators. Both tools are backed by media mention, peer word of mouth, and cross-disciplinary use, so all become very well known in teaching circles. It is the tendency of teachers to get information about these tools personally from colleagues, students, or social media and not through an institutionalized formal training. Such was the informal trend of diffusion that Kim and Kim (2023) noted and concluded that word-of-mouth communication and exposure through the internet play major roles in the adoption of these tools.

The same cannot be said of subject-based AI tools such as Khanmigo (18.2%) and Quillionz (25.0%), which are specially designed for teaching-learning functions. Their lower levels of awareness are either caused by less promotion, restricted availability in certain areas, or lack of institutional marketing. The finding supports the study of Luckin et al. (2022), who are of moderate opinion that without targeted institutional interventions, teachers do not know about specialized tools that can be more meaningfully aligned with their instructional needs.

Another point of interest is the rather low mean score on the item "My institution has introduced AI-related concepts to academic staff" ($M = 2.84$, $SD = 0.96$). This shows that exposure to AI in formal terms in the shape of structured institutional activities is low. Johnson et al. (2021) emphasize that institutional programs such as AI awareness workshops, departmental seminars, and demonstration projects are necessary to move the staff from awareness of only high-profile tools to a larger perspective of AI applications in teaching.

AI Integration Readiness

Readiness is not merely being aware of AI it is having the skills, resources, and institution capacity to utilize it best in teaching. While the subjects in this study expressed strong intention to adapt teaching methods to incorporate AI ($M = 4.29$, $SD = 0.79$), it was not accompanied by the training they received officially ($M = 3.02$, $SD = 1.09$). This capability-motivation gap is a common problem in technology adoption studies, as noted by Eickelmann and Gerick (2020), who established that teacher readiness generally lags behind teachers' favorable attitudes toward technological innovation.

The lack of systematic training is particularly urgent with the increasing complexity of certain AI technologies, specifically those involving integration with learning management systems or intricate data analytics. Teachers will either not utilize these technologies well enough or utilize them in a way that does not have any beneficial impact on learning without pedagogical walk-throughs and facilitated practice. Additionally, inconsistencies within digital infrastructure such as unequal access to the internet or antiquated hardware also make attempts at readiness difficult.

Regression analysis supports the premise that awareness is a primary motivator of readiness. This is consistent with Rogers' (2003) theory of Diffusion of Innovations, in which knowledge attainment is seen as a necessary step prior to the adoption decision. When teachers are informed about the potential and limitations of AI, they can more clearly visualize how it can be used in their own classrooms. On the other hand, a lack of awareness brings about uncertainty, sometimes causing the initial hesitation or resistance.

Demographic Variables and Integration with AI

The absence of robust effects for demographic variables such as gender, age, faculty rank, and teaching experience is a fascinating departure from some earlier research. Alenezi (2022) and Cabral et al. (2023) found in their research that

younger and male teachers tend to adopt new technology more quickly, possibly since they encountered them more often while undergoing training or possess greater digital confidence. This did not occur in this study.

One possible explanation for this outcome is the relatively recent and sudden mainstreaming of AI tools like ChatGPT that have been widely featured in popular culture and the media. Greater exposure on a mass scale could have decreased older-fashioned adoption differentials within demographic groups. Another possible explanation is the impacts of the COVID-19 pandemic, which forced nearly all teachers across age and sex groups to incorporate computer-based teaching tools into their pedagogical practices out of necessity (Zhang et al., 2021).

This finding has significant implications for policy at the institutional level: since demographic factors do not seem to be primary impediments to AI adoption in this setting, training and support initiatives can be created for an umbrella audience instead of being targeted to specific demographic groups. This simplifies implementation and can make it less costly, while still being inclusive.

Implications for Policy and Practice

The absolute link between awareness and readiness underscores the importance of institutional investment in AI literacy initiatives. Institutional investment in awareness-raising measures enables institutions to lay the ground for successful AI integration. This can be through developing faculty workshops, collaborative pilot projects, and mentoring initiatives where experienced AI users mentor others.

Institutions also need to fill the "visibility gap" between education-specific and general-purpose AI tools. While tools like ChatGPT may be applied to enhance instruction in the majority of contexts, discipline-specific tools will possess functionality more responsive to curriculum needs, like developing formative tests, tracking learning analytics, or providing adaptive learning experiences. Marketing such specialized tools in faculty development can expand the range of AI applications utilized in instruction.

Finally, since demographic variables are not significant, efforts to promote AI adoption can focus on the universal challenges of having stable internet, access to institutional licenses on AI resources, and professional learning rather than focusing on demographic personalization. All educators can be assisted equally from AI integration initiatives.

Conclusion

The study concludes that the Federal College of Education, Ilawe-Ekiti, is in a promising but vulnerable position regarding AI integration. While academic staff demonstrate interest, willingness, and general awareness of AI tools, practical readiness is limited by gaps in training, institutional exposure, and infrastructure. To achieve effective adoption, the institution must implement comprehensive training programs, develop clear policies on ethical use and curriculum integration, enhance infrastructure, and provide sustained technical support. By aligning staff enthusiasm with strategic institutional interventions, the college can translate interest into meaningful, widespread, and effective use of AI in teaching and learning.

Recommendations

Drawing on the findings and suggestions, some practical recommendations are proposed to guide institutional policy, staff development, and strategic planning for AI implementation.

1. Staff should be exposed to both widely used tools like ChatGPT and specialized educational AI platforms relevant to their teaching areas, while early adopters can serve as mentors to guide colleagues and share best practices through seminars, workshops, and peer learning sessions.
2. Practical preparedness for AI integration can be strengthened by providing hands-on workshops and pilot programs that allow lecturers to apply AI tools directly in their teaching. This approach will help translate positive attitudes into actionable skills, ensuring that staff can effectively incorporate AI into pedagogical practices.

3. To support the use of AI, the institution should develop a centralized resource hub offering curated AI tools, manuals, case studies, and access to licensed software. This hub would broaden staff exposure beyond popular AI tools and facilitate consistent use of educational platforms that enhance teaching and learning outcomes.
4. Regular training, peer learning, and institutional support should focus on ensuring that increasing familiarity with AI tools translates into tangible preparedness for integration.
5. A formal AI integration policy should guide ethical use, align AI implementation with curriculum goals, encourage AI-related research, and establish metrics for monitoring impact. Given that demographic factors do not significantly affect readiness, these interventions should be applied uniformly across all staff to ensure effective and widespread adoption.

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DIGITALIZATION AND FUTURE AUDITING AND ASSURANCE SERVICES AMONG CORPORATE FIRMS IN OGUN STATE

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Abstract

This study examined the impact of digitalization on the future auditing and assurance services among corporate firms in Ogun State, Nigeria. The research adopted a descriptive survey design, A total of eighty (80) participants were chosen through a simple random sampling technique, and seventy-two (72) completed questionnaires were retrieved for analysis. Data were collected using research questionnaire. The instrument's content validity was confirmed by three experts from the Department of Business Education, Tai Solarin University of Education, Ijebu-Ode, while its reliability was established through a test–retest method, yielding coefficients of 0.82 and 0.73. Data were analyzed using Pearson Product Moment Correlation (PPMC) for hypotheses one to three and Multiple Regression Analysis for hypothesis four through SPSS version 25 at .05 level of significance. Findings revealed that digitalization (data analytics ($r = 0.136$, $P < 0.05$), automation ($r = 0.118$, $P < 0.05$) and cybersecurity ($r = 0.213$, $P < 0.05$), had significant and positive relationships with the future auditing and assurance services. Also, there is composite influence ($F(3,68) = 415.814$, $p < .000$) of digitalization (data analytics, automation, and cybersecurity on the future auditing and assurance services in Ogun state). The study concludes that digitalization had positive relationships with the future auditing and assurance services. Compositely, digitalization had significant influence on the future auditing and assurance practices among corporate firms in Ogun State. The study recommends continuous technological adaptation and auditor training to enhance audit quality and ensure future relevance in a rapidly digitalized environment.

Keywords: Digitalization, Data Analytics, Automation, Cybersecurity, Auditing and Assurance Services

Introduction

The advent of digital technologies is transforming industries worldwide, and the auditing and assurance services sector is no exception. As corporate firms strive for efficiency, transparency, and accuracy in their financial reporting, the need for innovative solutions has never been more pressing. In particular, digitalization is reshaping how audits are conducted, offering new possibilities for enhancing audit quality, reducing costs, and improving the

timeliness of services. Technologies such as Artificial Intelligence (AI), big data analytics, cloud computing, and blockchain are increasingly being integrated into auditing processes, enabling more efficient, accurate, and comprehensive audit methodologies (Gartner, 2020).

Meanwhile, in Nigeria, there are significant economic hub with a rapidly expanding corporate sector. From manufacturing giants to financial institutions and tech startups, the diversity and growth of firms in this region underline the importance of efficient and reliable auditing services (Brynjolfsson & McAfee, 2020). As businesses navigate complex financial landscapes, the demand for auditing and assurance services that are both transparent and forward-thinking continues to rise. However, the integration of advanced digital tools into these services is still in its early stages, with many corporate firms yet to fully harness the potential benefits of digitalization.

While traditional auditing methods have served businesses for decades, the increasingly dynamic nature of corporate operations calls for a more agile and data-driven approach. Digitalization promises to transform auditing by providing more real-time insights, improving the quality of financial reporting, enhancing decision-making, and reducing human error. Nevertheless, the adoption of these technologies comes with its own set of challenges, including resistance to change, the need for extensive staff training, and the high initial investment in digital infrastructure (Julie et al., 2019).

In the context of auditing, technological innovations have radically transformed how audits are performed. The introduction of artificial intelligence (AI), big data analytics, blockchain, and cloud computing is changing auditing by enabling more accurate, timely, and cost-effective assessments of financial data (Julie et al., 2020). As a result, auditors are increasingly relying on these technologies to automate processes, analyze large datasets, and detect potential fraud, improving the efficiency and quality of audits (Kokina & Davenport, 2021; Moffitt et al., 2018). These advancements are reshaping the profession, leading to faster audits with fewer errors and more reliable results (Sjöberg & Johansson, 2021). Assurance services, a subset of auditing, have also evolved as digital technologies become more integrated into business practices. Assurance services are designed to enhance the reliability and quality of financial and non-financial information, providing decision-makers with the confidence they need to make informed choices Westerman, et al., 2019). They further stressed that these services are vital in today's globalized business environment, where stakeholders rely on accurate, trustworthy information to guide investment and regulatory decisions.

Digitalization allows audit firms to process, store, and transmit vast amounts of data at a fraction of the previous cost, making it easier to review financial statements and assess compliance with regulatory standards (Majchrzak et al 2019). The authors added that as emerging technologies continue to evolve, audit firms must adapt their strategies and business models to leverage the full potential of these tools. Despite the widespread recognition of the importance of digitalization in auditing, many audit firms are yet to fully embrace these changes, which could affect their ability to compete effectively in a rapidly changing market (Lombardi et al., 2015). For the auditing profession to remain relevant and valuable, it must continue to evolve in response to technological advancements. Emerging technologies such as AI, data analytics, and blockchain are already influencing how financial information is reported, analyzed, and audited (Julie & Chan, 2019). As digital tools become more sophisticated, auditors will

need to integrate them into their workflows to enhance their ability to detect anomalies, verify transactions, and ensure the accuracy of financial reports (Baldwin, 2020).

Despite the growing global trend towards digital audits, there is a gap in empirical research that specifically examines how digitalization is influencing auditing and assurance services among corporate firms in Ogun State. Understanding the extent to which firms in this region are embracing digital tools and the impact on audit outcomes is critical to determining how these firms can leverage technology for enhanced performance and compliance. Moreover, as digitalization continues to evolve, it is vital to explore how future developments in technology might further reshape the auditing profession. This study is therefore crucial for providing a deeper understanding of the digital transformation of auditing services in Ogun State.

Statement of the Problem

Despite the importance of digitalization in enhancing businesses in today's digital era, many corporate organisation such as auditing firms still find it difficult to use and adapt to the changes caused by digitalization. Technology has changed how business/organisation records filled and as well-kept for future purposes, which is totally different from the old styles. Additionally, most of the corporate organization are now adopting digital technology in preparing statement of accounting effective audit and assurance services coupled with reporting. Auditors in contemporary firms are facing significant challenges arising from advancements in information technology. Since auditing must remain a valuable service to investors, creditors, and other financial information users, auditors are now required to possess up-to-date knowledge and advanced technological skills. Consequently, the public accounting profession once considered traditional and slow to change has been compelled to experience major transformations since the beginning of the new millennium due to rapid IT developments.

Moreover, as the profession transitions toward greater digital integration, modifications in the auditing process have become inevitable. Researchers note that the digital evolution of auditing will reshape organizational structures and demand new skill sets within audit firms. The growing digitization of operations and the dynamic nature of clients' business models have also made auditing more complex, thereby increasing the demands placed on auditors. Many practitioners now struggle to carry out their duties effectively because of the challenges introduced by digitalization in audit practices. This situation highlights the importance of examining how digitalization influences the future auditing and assurance services among corporate organizations in Ogun State.

Objectives of the Study

1. To find out the relationship between data analytics and future auditing and assurance services among corporate firms in Ogun State
2. To examine the relationship between automation and future auditing and assurance services among corporate firms in Ogun State
3. To investigate the relationship between cybersecurity and future auditing and assurance services among corporate firms in Ogun State

4. To explore the composite influence of digitalization (data analytics, automation and cybersecurity) on future auditing and assurance services among corporate firms in Ogun State.

Research Hypotheses

$H0_1$: There is no significant relationship between data analytics and future auditing and assurance services among corporate firms in Ogun State

$H0_2$: There is no significant relationship between automation and future auditing and assurance services among corporate firms in Ogun State

$H0_3$: There is no significant relationship between cybersecurity and future auditing and assurance services among corporate firms in Ogun State

$H0_4$: There is no significant composite influence of digitalization (data analytics, automation and cybersecurity) on the future auditing and assurance services among corporate firms in Ogun State.

Literature Review

Empirical Studies on Digitalization and Future of Auditing

Appiah et al. (2022) investigated how cybersecurity threats affect the reliability and quality of digital auditing in financial institutions. Using data gathered from auditors and IT specialists in Ghana, the researchers discovered that cyber incidents such as ransomware, unauthorized access, and data leaks pose serious risks to audit confidentiality and accuracy. To mitigate these risks, auditors increasingly depend on cybersecurity standards and control frameworks like ISO/IEC 27001 to protect sensitive audit data. The study emphasized that integrating cybersecurity assurance into audit planning and procedures is essential for ensuring data integrity and maintaining public confidence. The study focuses on Ghanaian financial institutions, leaving a gap in understanding how similar challenges manifest in Nigerian corporate firms**,** particularly in Ogun State. While cybersecurity is emphasized, other aspects of digitalization such as automation and data analytics were not covered.

Rahman and Chowdhury (2023) examined how audit firms across Southeast Asia are preparing for the growing influence of cybersecurity on assurance services. Through interviews with senior auditors, the study revealed that many firms are shifting from traditional IT audit models to new forms of cybersecurity assurance engagements. These new approaches focus on evaluating clients' digital infrastructures, cybersecurity policies, and risk management systems. The authors found that technological competence, especially in cybersecurity, is becoming an essential skill for modern auditors. They concluded that the future of auditing lies in continuous, technology-driven assurance, where real-time monitoring and cyber risk evaluation will form the foundation of audit practice. The research centers on audit firms broadly, but does not explore how corporate firms in manufacturing, services, and agro-industries adapt to digital assurance practices.

Moffitt et al. (2020) explored how cybersecurity, artificial intelligence (AI), and continuous auditing collectively shape the next generation of assurance services. Their conceptual model proposed that combining blockchain and cybersecurity analytics could strengthen audit reliability and system transparency. The authors argued that as organizations become more digitalized, auditors will increasingly shift from examining past transactions to actively monitoring risks in real time. They further suggested that AI-based cybersecurity tools capable of detecting anomalies and assessing control environments will redefine the auditor's role. Ultimately, the study concluded that embedding cybersecurity intelligence into audit systems is critical to sustaining trust, protecting data integrity, and maintaining audit credibility in a highly interconnected business environment. Beyond cybersecurity and artificial intelligence investigated in their study, the current study fills the gap by integrating automation and data analytics into the discourse on digital auditing.

Grant Thornton (2018) provided deeper insights into digital transformation within the accounting profession. The report highlighted that while the Big Four accounting firms have made noticeable progress in digital integration, small and medium-sized firms face considerable challenges. These include limited profitability due to intense competition and fee undercutting, inadequate human resources, and insufficient access to large-scale data for digital auditing. Consequently, their capacity for technological transformation remains restricted. The report recommended that firms should prioritize workforce development and technological infrastructure upgrades since skilled personnel and robust systems are the foundation of digital auditing. Additionally, establishing clear regulatory frameworks and digital auditing standards, possibly drawing lessons from international practices, is vital for sustainable growth. Their study highlights the uneven progress of digital transformation in auditing, with SMEs constrained by resources and regulation. The current study is relevant because it situates these challenges within Ogun State's corporate firms, addressing workforce development, infrastructure, and regulatory adaptation in Nigeria's context.

Han et al. (2023) conducted a broad literature review that explored blockchain's transformative role in promoting transparency and trust within accounting practices. Their findings underscored blockchain's ability to enhance decision-making by maintaining immutable, consensus-based, and append-only records. Four key themes were identified from their review event-based accounting, real-time accounting, triple-entry accounting, and continuous auditing. Using agency theory and stakeholder theory as interpretive lenses, Han et al. (2023) provided a nuanced understanding of how blockchain reduces information asymmetry and strengthens stakeholder cooperation. They also acknowledged the complexities associated with adopting blockchain technology, advocating for measured,

context-specific implementation but their work leaves gaps in regional application, integration with other digital tools, and regulatory readiness. The current study is relevant because it explores blockchain's potential within Ogun State's corporate firms, linking it to cybersecurity, automation, and data analytics for future assurance services.

Similarly, Fedyk et al. (2022) examined how AI influences audit quality and efficiency using a dataset of over 310,000 resumes from leading audit firms. Their study revealed a growing AI-driven workforce composed mainly of young, technically skilled professionals, predominantly male. The findings indicated that AI functions within firms are typically centralized in specialized teams and geographic locations. Importantly, their results demonstrated a positive link between AI investment and enhanced audit quality and efficiency, reflected in lower audit fees and reduced dependence on human auditors. Interviews with audit partners further confirmed that AI adoption significantly elevates audit performance by improving precision and efficiency, offering a forward-looking perspective on the future of AI in auditing. But gaps remain in regional application, integration with other digitalization dimensions, and workforce inclusivity. This current study is relevant because it situates AI adoption within Ogun State's corporate firms, exploring how automation, data analytics, and cybersecurity can collectively shape the future of assurance services.

Vasarhelyi et al. (2015) revealed that adopting continuous auditing methods supported by data analytics enables auditors to detect irregularities in real time, resulting in more precise and timely audit outcomes. Artificial intelligence (AI) technologies particularly machine learning algorithms have also been instrumental in improving audit precision, as they can process complex patterns and vast datasets far more efficiently than conventional approaches. However, the degree to which digitalization influences audit accuracy differs across regions. For example, Albawwat and Al Frija (2021) discovered that in Jordan, the intricate nature of AI systems has created doubt among auditors regarding their reliability, thereby influencing perceptions of audit accuracy. Likewise, Afroze and Aulad (2020) reported that auditors in Bangladesh have demonstrated a slow rate of AI adoption, which may reduce audit precision due to insufficient technological integration.

The application of data analytics has significantly altered the workload within auditing practices. Through advanced analytical tools, auditors can manage and interpret extensive data sets effectively, making the audit process more efficient. Alles et al. (2008) noted that data analytics enables auditors to conduct broader and more detailed data examinations, thereby increasing the quantity of work achievable within a limited timeframe. Consistent with this,

Vasarhelyi et al. (2015) emphasized that analytics facilitate broader audit coverage by allowing the review of complete datasets rather than samples, which consequently expands the scope and workload that audit firms can handle.

Automation technologies have equally revolutionized the auditing profession by minimizing the time required for repetitive and routine tasks. Tools such as Computer-Assisted Audit Techniques (CAATs) streamline standard processes, thereby freeing auditors to focus on higher-value and more complex engagements. Sirisomboonsuk et al. (2018) observed that the automation of data extraction and processing has markedly increased the quantity of work audit firms can manage. Automation, by reducing manual intervention and accelerating audit procedures, enables firms to service more clients efficiently. AI-powered applications further enhance this capacity by improving auditors' ability to detect anomalies and analyze intricate datasets. As Kotsiantis et al. (2006) noted, AI systems can swiftly process massive amounts of data, supporting larger and more comprehensive audits. In addition, the predictive and analytical capabilities of AI extend the range of audit analyses (Moffitt et al., 2018). The three studies above collectively demonstrate how automation and AI enhance audit efficiency, anomaly detection, and predictive analysis. However, gaps remain in regional application, sectoral diversity, integration with cybersecurity, and regulatory adaptation. This current study is relevant because it situates these insights within Ogun State's corporate firms, addressing workforce readiness, regulatory needs, and the holistic integration of automation, AI, and data analytics into the future of auditing and assurance services.

METHODOLOGY

This study used a descriptive research design of survey type. The population for this study comprised managers and internal auditors of corporate firms in Ogun State. The sample size comprised eighty participants using simple random sampling technique. But out of the 80 questionnaires that were sent, only 72 were appropriately filled and returned. This serves as the real sample used in this study. The major research instrument used in this study was a questionnaire. The questionnaire was categorized into three sections: Section A focused on the demographic characteristics of the respondent, while section B consists of items on digitalization while section C focused on the items on the future of auditing and assurance services in Ogun State. The respondents are either to Strongly Disagree (SD), Disagree (D), Agree (A) or Strongly Agree (SA). The instruments were subjected to content validation by three experts from the Department of Business Education at Tai Solarin Federal University of Education, Ijebu-Ode, Ogun State. The reliability of the instrument was established using test-retest reliability method. Within an interval of two weeks, the researcher re- administered the same questions to the same set of 10 participants in Lagos state, who were not part of the sample drawn, their responses were subjected to analysis, which yielded a reliability coefficient 0.82 and .73 respectively. Pearson Product Moment Correlation (PPMC) was used to test the hypothesis one to three, while

Multiple Regression Analysis was used to test hypothesis four, the analysis was done using SPSS version 25 at .05 level of significance.

Results and Discussion of Findings

Testing of Hypotheses

H_{01}: There is no significant relationship between data analytics and future auditing and assurance services among corporate firms in Ogun state.

Table 1: A table showing the relationship between data analytics on future auditing and assurance services among corporate firm.

Variables	N	Mean	SD	df	r-value	p-value
Digital Analytics		37.36	.83			
Future auditing and assurance services	72	47.37	.72	3	.136	.010

Table 1 indicates that there is significant ($r = 0.136$, $P < 0.05$) relationship between data analytics and the future of auditing and assurance services among corporate firms in Ogun State. On this premise, the null hypothesis one was rejected and the study concludes that data analytics significantly impact on the future auditing and assurance services among corporate firms in Ogun State. This finding is in line with the finding of Vasarhelyi et al. (2015) who revealed that adopting continuous auditing methods supported by data analytics enables auditors to detect irregularities in real time, resulting in more precise and timely audit outcomes. However, the degree to which digitalization influences audit accuracy differs across regions. For example, Albawwat and Al Frija (2021) discovered that in Jordan, the intricate nature of AI systems has created doubt among auditors regarding their reliability, thereby influencing perceptions of audit accuracy. Likewise, Afroze and Aulad (2020) reported that auditors in Bangladesh have demonstrated a slow rate of AI adoption, which may reduce audit precision due to insufficient technological integration.

H_{02}: There is no significant relationship between automation and future auditing and assurance services among corporate firms in Ogun State.

Table 2: A table showing the relationship between automation and future auditing and assurance services among corporate firms.

Variables	N	Mean	SD	df	r-value	p-value
Automation		24.33	.84			
Future auditing and assurance services	72	11.49	.73	3	.213	.010

Table 2 above shows a significant relationship between automation and future auditing and assurance services of corporate firms in Ogun state ($r = 0.213$, $P < 0.05$). On this premise, the null hypothesis two was rejected and the study concludes that a significant and positive relationship exists between automation and future auditing and assurance services in Ogun state. The implication is that digitally literate personnel are more likely to implement or support digital transformation in audit practices. This finding highlights the importance of training and upskilling in digital technologies as a key enabler of effective auditing reform. This result corroborates Sirisomboonsuk et al. (2018) who observed that the automation of data extraction and processing has markedly increased the quantity of work audit firms can manage. Automation, by reducing manual intervention and accelerating audit procedures, enables firms to service more clients efficiently.

H_{03}: There's no significant relationship between cybersecurity and future auditing and assurance services among corporate firms in Ijebu ode local government

Table 3: ***A table showing the relationship between cybersecurity on future auditing and assurance services.***

Variables	N	Mean	SD	Df	r-value	p-value
cybersecurity		11.01	.92			
Future auditing and assurance services	72	5.17	.77	3	.118	.010

Table 3 above indicates that there was significant relationship ($r = 0.118$, $P < 0.05$). between cybersecurity and the future auditing and assurance services among corporate firms in Ogun state. On this premise, the null hypothesis three was rejected and the researchers concluded that there is a significant relationship between cybersecurity and the future of auditing and assurance services among corporate firms in Ogun state. This study is in line with Appiah et al. (2022) who investigated how cybersecurity threats affect the reliability and quality of digital auditing in financial institutions. Their study emphasized that integrating cybersecurity assurance into audit planning and procedures is essential for ensuring data integrity and maintaining public confidence. Also, this outcome corroborates the study of Rahman and Chowdhury (2023) examined how audit firms across Southeast Asia are preparing for the growing influence of cybersecurity on assurance services. Through interviews with senior auditors, the study revealed that many firms are shifting from traditional IT audit models to new forms of cybersecurity assurance engagements. These new approaches focus on evaluating clients' digital infrastructures, cybersecurity policies, and risk management systems. The authors found that technological competence, especially in cybersecurity, is becoming an essential skill for modern auditors.

H_{04}: There is no significant composite influence of digitalization (data analytics, automation and cybersecurity) on the future of auditing and assurance services among corporate firms in Ogun State.

Table 4: A table showing the regression model on composite influence of digitalization (data analytics, automation and cybersecurity) on the future of auditing and assurance services among corporate firms in Ogun State.

Model	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Regression	13422.218	3	5426.213	415.814	.000[b]

Residual	2215.202	68	21.275
Total	14243.420	71	

Note. **N= 72, R= .790, R^2= .624, Adj. R^2= .623**

The table 4 above shows significant composite influence of digitalization (data analytics, automation and cybersecurity) on the future of auditing and assurance services among corporate firms in Ogun State. The regression model demonstrates that there is a significant composite influence (F (3,68) = 415.814, p < .000) of digitalization (data analytics, automation and cybersecurity) on the future of auditing and assurance services among corporate firms in Ogun State. The model explains 62.3% of the total variance in future of auditing and assurance services among corporate firms in Ogun State. 0.623 is slightly higher due to rounding; this confirms a strong and generalizable model fit. Residual mean indicates the average unexplained variance, which is moderate**,** given the high R^2. Collectively, data analytics, automation and cybersecurity jointly accounted for over 70% of the variation in. This means these three factors are major contributors to the future of auditing and assurance services among corporate firms. The model's statistical significance (p = .000) confirms that the influence is not due to chance, and the results can be confidently generalized.

Conclusion

This study concludes that there is a significant and positive relationship between data analytics**,** automation**,** and cybersecurity with the future of auditing and assurance services. Moreover, the composite influence of digitalization encompassing these three dimensions demonstrates that digital transformation is not merely an option but a strategic necessity for corporate firms in Ogun State. The study contributes to the literature by providing context-specific evidence from a developing economy, thereby extending global debates on digital auditing into the Nigerian corporate environment. It highlights how digitalization can enhance audit quality, efficiency, and integrity, while also underscoring the importance of capacity building in both technological tools and professional skills. From a policy perspective, the findings reinforce the need for regulatory frameworks, professional standards, and oversight mechanisms that support digital auditing practices. Policymakers and professional bodies must prioritize investments in auditor training, digital infrastructure, and cybersecurity protocols to ensure sustainable adoption. By bridging the gap between global best practices and local realities, this study provides actionable insights for regulators, firms, and practitioners to harness digital transformation as a driver of trust, transparency, and resilience in auditing and assurance services**.**

Recommendations

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

i. Universities and professional bodies should integrate digital competency programs into accounting curricula.

ii. Corporate firms must allocate budgets for digital infrastructure (e.g., audit software, cloud tools).

iii. Government agencies (e.g., NDIC, FRCN) should provide grants or tax incentives for firms adopting digital audit tools.

iv. Tailor digital tools to smaller firms in Ogun state by offering scalable, cost-effective solutions.

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PERCEIVED INFLUENCE OF DIGITAL LEARNING TECHNOLOGY ON ACADEMIC PERFORMANCE OF BUSINESS EDUCATION UNDERGRADUATES IN LAGOS STATE PUBLIC TERTIARY INSTITUTIONS

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Abstract
This study examined the perceived influence of digital learning technology utilisation on academic performance of business education undergraduates in Lagos state public tertiary institutions. A descriptive survey design was adopted. the population consisted of 300-level business education undergraduates from the University of Lagos (n = 146) and Lagos State University (n = 85). Raosoft sampling technique was used to select the sample size from the population. The sample for each university was: University of Lagos (106) and Lagos State University (70). Data were collected using a structured questionnaire titled *Questionnaire on Digital Learning Technology Utilisation and Academic Performance of Business Education Undergraduates in Lagos State Public Tertiary Institutions (QDLTUAPBEULSPTI)*. The instrument was face and content validated by a Business education expert in the University of Lagos. Also, the instrument was subjected to test-retest which yielded coefficient of 0.75, indicating high reliability of the instrument. Three objectives, three research questions and three hypotheses guided the study, respectively. Findings revealed that Business education undergraduates found digital learning technology credible and useful, but faced various challenges in the utilisation of digital learning technology. The study also found that not all the digital learning tools (Blackboard, Canvas, e-library and accounting software) recommended by the Basic Minimum Academic Standards (BMAS) were fully adopted or utilised by the institutions. Based on these findings, it was recommended that Business Education students receive training to enhance their ability to navigate and effectively utilize digital learning technologies both within and beyond the classroom environment.

Keywords: Business Education, Digital Learning Technology, Utilization, Academic Performance

Introduction

One of the significant outcomes of the contemporary knowledge explosion is the breakthrough in digital technology and its application to all areas of human endeavours, the education field inclusive. As the world continues to evolve rapidly, the need to catch up with the unfolding and its implications on education cannot be overemphasised. This is because the advent of digital technology to directional changes and narratives of conventional teaching and learning that cannot be negotiated. These days, teaching has gone beyond the teacher's dominance, nor is it restricted to the four walls of the classroom. Anene, Imam and Odumuh (2014) stated that education has shifted from the traditional form of education towards new methods of teaching and learning through the explosion of Information and Communication Technologies (ICT). Therefore, with the evolution of digital learning materials and tools, students can learn at their own time, pace and comfort easily with or without teachers' support and intervention, leading to improved personalised learning, students' engagement, better academic performance and productive teaching.

Conceptual Framework

Digital learning technology (DLT) is the integration of digital tools into education to promote effective teaching and learning in and outside the school. It is the application of digital learning innovation in education to facilitate seamless teaching, improve learning, and promote self-regulated learning. According to Bansilal (2015), these technologies encompass various communication, information, and technological tools that enhance teaching, development, and assessment practices. The digital technology in educational contexts include but not limited to as e-learning, online learning, web-based learning, virtual learning environment (VLE), and massive open online courses (MOOC) (Daniel, 2014). Undie (2023) defines digital learning technology (DLT) as teaching and learning tools that are created digitally or through digitisation of analogue materials. This shift in education underscores the important roles digital learning innovation plays in shaping the quality of education digitally.

Undies (2023) also stated that technology enriches classrooms with digital learning aids like computer and portable devices to improve teaching and learning. While the use of digital technology in education can be fun, entertaining and challenging, it nonetheless enables students and teachers collaboratively organize classes without having to come in contact physically, meaning that instructional contents can be meaningfully delivered through digital e-learning tools like blackboard, Google classroom, Canvas etc. Bizmana and Orodho (2014) emphasises that these tools include simulation, animation, quizzes, electronic textbooks, learning objects, graphic, photographs or photos, audio, video, and other digitally formatted capabilities. Organization for Economic Co-operation and Development (2016) further emphasized that digital learning innovations include digital courseware, core learning technologies, design-based procedures, or related solutions that faculty and institutions can use to improve student access and/or learning.

From the foregoing, it is critical to unequivocally state that the widespread use of digital learning technology became pronounced and popular in the year 2020 when the outbreak of the COVID-19 pandemic interrupted world's socio-economic and academic activities in schools across the globe thereby forcing schools to improvise, as a matter of urgency, on content selection and delivery. The transition was a bit difficult for most teachers, especially the ones in government schools, because of their lack of exposure and technical know-how to digital technology. Moorhouse and Kohnke (2021) averred that teachers were unprepared and ill-equipped to deal with the intimidating transition to online, blended, and Hy Flex learning. Adelakun et al. (2023) also identified weak internet connectivity as a major barrier to the effective utilisation of digital learning technologies among students in Nigerian tertiary institutions. Their study emphasised that unstable network services and high data costs significantly reduced students' engagement with online learning platforms.

Today, the digital revolution has been sustained by most institutions in the post-COVID-19 era. Besides, curriculum has been reformed to include the use of digital learning technology to promote teaching efficacy in schools. In addition to curriculum reform, Basic Minimum Academic Standard (BMAS) was also restructured to incorporate the application of digital tools in teaching and learning process. Nigerian University Commission (NUC) through Basic Minimum Academic Standard (BMAS) now explicitly requires blended learning, an ICT-oriented curriculum, and an emphasis on entrepreneurship and 21st-century skills- all of which provide a foundational policy-level mandate for

digital learning innovation in Business Education. They further highlight unprecedented relevance of digital technology in Nigerian education sector.

Within this evolving landscape, Business Education stands out as a dynamic, interdisciplinary field that prepares students for gainful employment, entrepreneurship, and the teaching profession. Therefore, for Business education to be relevant and responsive, digital learning technologies must be integrated into its curriculum to enhance employability and entrepreneurial readiness among graduates. As a multifaceted course, Business Education is an academic discipline that instils skills, knowledge and attitude in students to become job-ready and relevant to society. According to Otum (2018), Business education is defined as a programme of study that teaches the learners necessary skills, knowledge, attitude and competencies needed for employment, advancement on a job and self-reliance. Aliyu (2013) highlights some objectives of Business education, which are: the need for specialized instruction to prepare students for career in business, developing in students' fundamental instruction to help them assume their economic roles as consumers, workers, and citizens and equipping them with background instruction to assist them in preparing for professional careers and pique their interest in advanced study. To Okoro (2020), Business education is a branch of vocational education that provides students with requisites kills, abilities and competencies both mental and physical that equip the learners with knowledge and skills to teach effectively, work in an office or be self-reliant.

Business Education, as a course in tertiary institutions, comprises of Accounting option, Marketing options, Management option, Secretarial option and Entrepreneurship option. Students can major into any of them. Teaching and mastery of any of these options requires the use of digital technology because each of the option has enjoined rapid transformation over time. In Accounting and Management, Enterprise Resource Planning (ERP) has replaced traditional method of book-keeping, record-keeping and management of human and non-human resources. According to Bupo, Anireh and Godpower (2023), utilization of software packages in educational institutions involve routine activities as training, setting up accounts charts, existing data conversion, interfaces with existing platforms, and even consultation with other experts for effective teaching and learning process for the various courses and programmes offered such as Accounting courses in Business Education programme. In Marketing and Entrepreneurship, transactions are being facilitated digitally. We now have digital marketing, social media marketing and other forms of e-marketing carried out on TikTok, Facebook, Instagram etc.

Therefore, for Business education students to fully understand some of the abstract business-related concepts and align perfectly well with what is currently obtainable in society and industry at large in the 21st century, they need to be digitally instructed and fluent not only for acquisition of relevant skills and competencies but also for application of acquired knowledge to solve contemporary problems practically. Falobi (2022), asserted that business education is education for self-development and economic empowerment. This statement reinforces the relevance of business education for self-employment and national development. Amoor (2012) describes Business education as a form of vocational education that is directed towards developing the learners to become productive in teaching, paid employment and self-employment. Njoku, Julie and Nwachukwu (2019) stated that for business education to provide the individual with the knowledge, skills and attitude needed to take up readily available job openings in the global

job market, it becomes imperative that the educational system must function optimally and the teachers be professionally equipped to provide the requisite knowledge, skills and attitude that will enable the individuals avail themselves of the job openings and opportunities in the global market.

Central to the efficacy of digital learning technology (DLT) on academic performance is its usage and utilisation during the teaching and learning process. Utilisation of digital learning technology is a deliberate process of putting digital tools and resources into use to supplement and improve teaching and learning both inside and outside the classroom. According to Al-Fraihat, Joy and Sinclair (2020), utilisation of digital tools refers to the deliberate and effective use of digital technologies and resources to support, enhance, and facilitate teaching and learning processes, enabling better engagement, knowledge acquisition, and academic performance. The assessment of traditional teaching methods has brought about a shift in education, culminating in the adoption of digital learning technology (DLT) to upscale teaching and learning and to address the challenges associated with teacher-centred pedagogies. BMAS has recommended the utilisation of digital learning technology (DLT) in universities. To this end, lecturers are expected to leverage their techno-pedagogical skills to promote effective and goal-oriented teaching. The essence of this study is to determine the value, position, and impact of digital technology on students' academic performance so that observed challenges can be addressed, leading to the betterment and refinement of the digital teaching and learning process.

Theoretical framework

The theory upon which this study is anchored is the Technology Acceptance Model (TAM) propounded by Davis (1986).

Technology Acceptance Model (TAM)

Propounded by Davis in 1986, Technology Acceptance Model (TAM) provides the theoretical framework for understanding perceived usefulness and ease of usage of technology. David proposed that users' attitudes toward specific systems are a function of two major beliefs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU is defined as the degree to which a person believes that using a particular system would enhance his or her job performance. Individuals view a system positively (an attitude) if they think it improves their job performance (where they perceive its usefulness). They develop a positive attitude and increase their readiness to engage (a behaviour intention) in the usage of the system. On the other hand, PEOU is defined as the degree to which a person believes that using a particular system would be free of effort, meaning that the usage of technology is easy to achieve a particular goal or complete a particular task. Attitude refers to the degree of evaluative affect an individual associates with using the target system. This theory is relevant to this study in the sense that when business education undergraduates develop positive mindset towards the perceived usefulness and ease of use of digital learning tools in business education programme, it will not only help to foster effective teaching and learning outcome but also help in the attainment of business education goals and objectives.

Statement of the problem

In today's rapidly evolving digital age, the integration of digital tools into educational practices has become not just a luxury but a necessity, particularly in business education, where students are expected to develop competencies aligned with the demands of the 21st-century workplace (Okoro & Made, 2020; Bassey & Akpan, 2021). Over the years, the lecturers of Business education have largely relied on traditional teaching and learning pedagogies in universities, where students are regarded as passive recipients of knowledge, while lecturers dominate the teaching-learning process. Although this method has produced notable outcomes in the past, but its limitations have become increasingly evident with the rapid advancement of technology, evolving societal expectations, and the growing need to cater for students' diverse learning needs, e-teaching and learning and self-paced learning. One of the major criticisms of the traditional teaching approach is its inability to support learner autonomy, personalised pacing, technology-driven instruction and individual exploration. In response to these challenges, educational stakeholders have increasingly advocated for the application, integration, and utilisation of digital technology in teaching and learning, an approach that allows learners to study at their own pace, engage actively with learning materials, and take ownership of their educational journey. While several studies have examined the effectiveness of digital technology on student academic performance in Nigerian universities, there remains a significant gap in research focused on digital learning technology utilisation on the academic performance of business education undergraduates in Lagos state tertiary institutions. Therefore, this study aims to assess digital learning technology utilisation on academic performance of business education undergraduates in Lagos state tertiary institutions. By examining how digital technology has revolutionised teaching and learning in universities, this research seeks to contribute valuable insights towards continuous refinement of technological integration in Nigerian universities.

Objectives

The objectives of this study are specifically stated below:

1. To investigate the perceived relevance of digital technology on the academic performance of Business education undergraduates.
2. To examine the perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purposes
3. To examine the challenges encountered by Business education undergraduates in the use of digital learning technology for academic purposes.

Research Questions

1. What is the perceived relevance of digital learning technology on the academic performance of Business education undergraduates?
2. What is the perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purposes?
3. What are the challenges Business education undergraduates face in the use of digital learning technology for academic purposes?

Hypothesis

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

Ho1: There is no significant difference in the mean ratings of male and female Business Education undergraduates on the perceived influence of digital learning technology on academic performance.

Ho2: There is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the perceived ease of use, usefulness and credibility of digital learning technology

Ho3: There is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the challenges encountered in the use of digital learning technology.

Methodology

A **descriptive survey design** was adopted for this study, which was conducted in **Lagos State, Nigeria**. The population consisted of full-time **Business Education undergraduates in year three** from two tertiary institutions: **University of Lagos** (population = 146) and Lagos State University (population = 85). Raosoft sampling technique was used to select the sample size. The sample for each university was: University of Lagos (106) and Lagos state University (70). This level was selected for this study because students at this level have been adequately exposed to different kinds of digital learning tools and they are familiar with their utilisation. The research instrument used was a structured questionnaire titled: *Questionnaire on Digital Learning Technology Utilisation and Academic Performance of Business Education Undergraduates in Lagos State Public Tertiary Institutions (QDLTUAPBEULSPTI)*. The instrument was face and content validated by Business education expert in University of Lagos. Also, the instrument was subjected to test re-test which yielded co-efficient of 0.75, indicating high reliability of the instrument. The instrument contained **30 items** measured on a **5-point Likert scale,** ranging from **Very High Extent (5)** to **Neutral (1).** The questionnaire underwent **face and content validity** by an expert in Business Education from the **Un**iversity of Lagos**.** Questionnaires were administered in both institutions with the assistance of **two trained research assistants**. All the questionnaire administered were completely retrieved. The data collected were analyzed using **mean and standard deviation**. For decision-making, any item with a **mean score of 3.0 or**

above was interpreted as **High Extent**, while items with a **mean score below 3.0** were interpreted as **Low Extent**. For hypotheses testing, T-test independent was used at 0.05 significance level. The null hypothesis was accepted where the calculated value is less than the significant level of 0.05 and rejected if the calculated value is equal to or greater than the significant level of 0.05.

Results

Research Question One: What is the perceived influenced of digital learning technology on academic performance of Business education undergraduates?

Table 1: Mean Scores and standard deviation of responses on the perceived influence of digital learning technology on the academic performance of Business education undergraduates?

S/N	Statements	FX	Mean	SD	Remark
1	I regularly use digital tools for academic tasks like research and assignments.	726	4.13	1.21	Hight Extent
2	Digital platforms have improved my academic performance.	711	4.04	0.80	Hight Extent
3	Digital tools help me understand complex business concepts.	601	3.41	1.61	Hight Extent
4	I feel more confident in my studies when using digital resources.	686	3.90	0.69	Hight Extent
5	My academic performance has improved with digital tools.	675	3.84	1.17	Hight Extent
6	Digital tools help me collaborate effectively with peers.	650	3.69	0.95	Hight Extent
7	Online assessments are fair compared to paper-based ones.	698	3.97	1.08	Hight Extent
8	My grades have improved since using digital tools regularly	630	3.58	0.74	Hight Extent
9	Digital tools make learning more engaging.	636	3.61	1.42	Hight Extent
10	Digital tools have positively impacted my overall learning experience.	622	3.53	1.89	Hight Extent
Grand Mean			3.77		**High Extent**

Source: Researcher's field survey data, 2025.

Analyses on Table 1 reveals that the mean scores range from 3.53 – 4.13, indicating that the respondents rated highly extent on statements in items 1-10. Data in Table 1 further reveals average mean from question 11-20, which is 3.77. This indicates that there is perceived influenced of digital learning technology on academic performance of Business education undergraduates.

Research Question Two: What is the perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purpose?

Table 2: Mean Scores and standard deviation of responses on the perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purpose?

S/N	Statements	FX	Mean	SD	Remark
11	I find it easy to use Office productivity tools (Word, Excel,) for my learning and assignments	726	4.13	1.80	High Extent
12	I encounter no challenges in the utilization of Cloud collaboration tools (Google docs, Slides, Sheet) for my learning	664	3.77	0.90	High Extent
13	Learning Management System (Google classroom) is easy to use and creditable for online classes and assignment	607	3.45	1.40	High Extent
14	Typing/Keyboarding tool is relatively easy to use in my school for practical learning	602	3.42	1.05	High Extent
15	Accounting software (sage, QuickBooks) is used for Business education accounting option students.	501	2.85	1.61	Low Extent
16	Presentation tools (Power point) are available for easy usage for class and assignment presentation	546	3.10	1.98	High Extent
17	Learning Management System (Canvas) and electronic library is used for online classes and assignment	485	2.76	1.45	Low Extent
18	My lecturers regularly hold classes online using various digital learning tools.	579	3.29	1.14	High Extent
19	Social media for learning (YouTube, Telegram, WhatsApp) are often used for academic-related activities	656	3.73	1.04	High Extent
20	Learning Management System (Blackboard) is easy to use and credible for online classes and assignment	526	2.99	1.32	Low Extent
Grand Mean			3.35		**High Extent**

Source: Researcher's field survey data, 2025

Analyses on Table 2 reveals that the mean scores range from 2.76– 4.13, indicating that the respondents rated highly extent on statements in items 11-20. Data in Table 3 further shows average mean from question 11-20, which is 3.35. This indicates that there is perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purpose

Research Question Three: What are the challenges Business education undergraduates face in the use of digital learning technology for academic purpose?

Table 3: Mean Scores and standard deviation of responses on challenges Business education undergraduates face in the use of digital learning technology for academic purpose

S/N	Statement	FX	Mean	SD	Remark
21	I have no regular access to digital devices for learning.	768	4.36	1.11	High Extent
22	My internet access is not stable enough for academic use.	686	3.90	1.42	High Extent
23	I experience frequent disruptions due to poor network or electricity	663	3.77	1.77	High Extent
24	I am familiar with learning platforms like Google Classroom	698	3.97	1.35	High Extent

25	Digital tool like Canvas is not fully utilized for instructional delivery because of its complexity	683	3.88	1.71	High Extent
26	I have not received formal training on using digital tool like Blackboard for academic use	678	3.85	1.31	High Extent
27	I cannot afford regular data subscriptions for online learning.	665	3.78	1.97	High Extent
28	I get easily distracted while using digital platforms for learning.	717	4.07	1.42	High Extent
29	Lecturers do not provide adequate support in the use of digital tools.	764	4.34	0.87	High Extent
30	Using digital tools for learning is difficult for me.	660	3.75	1.53	High Extent
Grand Mean			3.97		**High Extent**

Source: Researcher's field survey data, 2025.

Analyses on Table 3 shows that the mean scores range from 3.75 – 4.36, indicating that the respondents rated highly extent on statements in items 21-30. Data in Table 2 further reveals average mean from question 21-30, which is 3.97. This indicates that Business education Undergraduates face different challenges to a large extent in the utilization of digital learning technology for academic purpose.

Ho1: There is no significant difference in the mean ratings of male and female Business Education undergraduates on the perceived influence of digital learning technology on academic performance

Table 4: T-test analysis of the difference between the mean ratings of male and female Business Education undergraduates on the perceived influence of digital learning technology on academic performance.

Group	Number	Mean	SD	DF	T.cal	T.tab	Level of sig	Decision
Male	25	1.60	0.57	174	0.36	1.96	0.05	NS
Female	151	2.37	0.88					

The t-test analysis presented in Table 4 revealed that the t-calculated (t-cal) value of 0.36 is less than the t-table (t-tab) value of 1.96 at P≤ 0.05 levels of significance and at 174 degrees of freedom (DF). This analysis showed that there is no significant difference between the mean ratings of male and female Business Education undergraduates on the perceived influence of digital learning technology on academic performance. Therefore, the null hypothesis of no significant difference is accepted.

Ho2: There is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the perceived ease of use, usefulness and credibility of digital learning technology

Table 5: T-test analysis of the difference between the mean ratings of Business Education undergraduates from the University of Lagos and Lagos state university on the perceived ease of use, usefulness and credibility of digital learning technology.

Group	Number	Mean	SD	DF	T.cal	T.tab	Level of sig	Decision
UNILAG	106	1.35	0.48	174	0.27	1.96	0.05	NS
LASU	70	1.99	0.89					

The t-test analysis presented in Table 6 revealed that the t-calculated (t-cal) value of 0.27 is less than the t-table (t-tab) value of 1.96 at P≤ 0.05 levels of significance and at 174 degrees of freedom (DF). This analysis showed that there is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the perceived ease of use, usefulness and credibility of digital learning technology by business education undergraduates for academic purposes.

Ho3: There is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the challenges encountered in the use of digital learning technology

Table 6: T-test analysis of the difference between the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the challenges encountered in the use of digital learning technology

Group	Number	Mean	SD	DF	T.cal	T.tab	Level of sig	Decision
UNILAG	106	1.45	0.56	174	1.93	1.96	0.05	NS
LASU	70	2.32	0.67					

The t-test analysis presented in Table 5 revealed that the t-calculated (t-cal) value of 1.93 is less than the t-table (t-tab) value of 1.96 at P≤ 0.05 levels of significance and at 174 degrees of freedom (df). This analysis showed that there is no significant difference in the mean ratings of Business Education undergraduates from the University of Lagos and Lagos State University on the challenges encountered in the use of digital learning technology. Therefore, the null hypothesis of no significant difference is accepted.

Discussion of Findings

The first finding in this study showed that digital learning technology (DTL) influences academic performance of Business education undergraduates in Lagos state institutions to a large extent. From the study, it was discovered that most Business education undergraduates have access to digital tools and make use of them in their learning. Therefore, the use of digital learning tools makes their learning more engaging, resulting into improved academic performance. This finding is in line with Amoor (2012) who submitted that lecturers and students utilize e-learning resources for effective teaching and learning in business education course to a moderate or low extent

The second finding in this study revealed that despite the benefits Business Education undergraduates in Lagos State institutions derive from the use of digital learning tools, they face a variety of challenges. These include difficulty in navigating certain digital tools, disruptive internet service, distractions during digital learning sessions, lack of technical support from lecturers, and inconsistent access to some digital devices. This aligns with the findings of **Njoku, Julie and Nwachukwu (2019)** who stated that factors such as inequality of access to the technology itself by all the students because it is very expensive to get some of the software for e-learning programme and electricity instability are the major challenges that hinder the application of e-learning in business education programme. This

finding also corroborates with findings by Adelakun**, et al. (2023)**, who identified **weak internet connectivity** as a major barrier to the effective use of digital learning technologies among students.

Another key discovery in this study is the variety of digital learning technologies available to Business Education undergraduates in Lagos state institutions. The findings revealed that although students have access to a range of digital tools, such as office productivity applications (excel, MS words), cloud-based collaboration tools (Google classroom) and presentation software (PowerPoint), there remains a notable lack of access to some digital learning technology such as blackboard and accounting software (e.g., QuickBooks, Sage). This indicates a gap between the digital learning technologies available to students and the comprehensive toolset recommended by the **Basic Minimum Academic Standards (BMAS)**. As such, not all the digital learning technologies mandated by **BMAS** are being effectively implemented or utilised across Lagos state public institutions offering the Business Education program. This corroborated the finding of Bupo, Anireh and Godpower (2023) whose study revealed that accounting software are not available for the learning of Business Education accounting courses in Rivers State universities.

Conclusion

There is no doubt that digital learning technologies play a vital role in the teaching and learning processes of Business Education undergraduates. These tools have contributed significantly to student engagement, academic performance, and overall instructional effectiveness. Given their transformative impact, the continuous integration and utilisation of digital technologies in education is essential. Accordingly, curricula should be regularly reviewed and updated to reflect current technological trends relevant to modern education. Furthermore, institutions must ensure that all recommended digital learning tools are not only implemented but also that both lecturers and students receive adequate training on their effective use.

Recommendations

The following recommendations were made based on the study's findings

1. Higher institutions should make digital devices, specifically Laptops and modems, a compulsory requirement for business education undergraduates. This will drastically solve the problem of inaccessibility to digital devices.
2. There should be complete and full integration, application, utilisation and implementation of all recommended digital learning tools so that Business education undergraduates, regardless of specialisation, will have equal and unrestricted access to digital learning tools
3. Students should be thoroughly trained on the effective usage of digital learning technology for easy navigation in and outside the school environment.

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ARTIFICIAL INTELLIGENCE IN BIOLOGY EDUCATION: A PATH TO INCLUSIVE LEARNING IN SECONDARY SCHOOLS IN KWARA STATE

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Abstract

This study examine how Artificial Intelligence (AI) can enhance inclusive learning in secondary school biology classrooms across public and private schools in Kwara State, Nigeria. Using a descriptive survey of 300 Biology teachers, data were collected through a validated questionnaire and analyzed descriptively. The study examined AI tool usage, teacher readiness, effectiveness, and access disparities. Findings showed that AI tools such as intelligent tutoring systems, virtual labs, and gamified applications promote inclusivity by accommodating diverse abilities, providing personalized instruction, and supporting students with disabilities. However, private schools had greater access and usage than public schools, highlighting infrastructural and training gaps. The study concludes that AI has strong potential to make Biology education more equitable and engaging and recommends integrating AI into the curriculum, improving teacher training, enhancing infrastructure, and fostering public and private partnerships to ensure all students benefit equally.

Keywords: Artificial Intelligence, Inclusive Learning, Biology Education, Teacher Readiness and Public and Private Schools

Introduction

The rapid evolution of education presents a prime opportunity to leverage artificial intelligence (AI) to make learning more inclusive, personalized, and effective. This is particularly crucial in Biology education, a foundational science that not only informs students' understanding of the natural world but also prepares them for vital careers in health, research, and environmental fields (Agboola, 2025). Despite its significance, access to high-quality Biology education remains uneven, especially for students from marginalized communities or under-resourced schools. Inconsistent teaching quality, limited resources, and generic teaching methods often lead to substantial achievement gaps (Omoseebi, 2021). As educators and policymakers seek solutions to these persistent inequities, AI emerges as a powerful tool to bridge this divide.AI-enhanced personalization involves using intelligent systems to tailor learning experiences to individual student needs, preferences, and progress (Shuaibu et al.,2024). In Biology education, this means students can receive customized support, whether they are grappling with basic cellular concepts or delving into complex areas like genetics or ecology.

Adaptive platforms can monitor performance in real-time, suggest personalized content, and provide timely feedback, allowing learners to advance at their own pace. This level of personalization is particularly valuable in Biology, where students often need visualizations, simulations, and scaffolded problem-solving to grasp abstract and complex ideas.AI can democratize access to quality Biology content and instruction (Olaide et al., 2024). Students in rural areas or schools with limited staff can benefit from virtual labs, interactive tutorials, and intelligent tutoring systems that mimic the support of a skilled teacher. Through natural language processing, AI-powered tools can also help students develop scientific literacy, enabling them to engage more confidently with scientific texts and inquiry-based tasks (Wakil et al., 2024). By overcoming barriers related to geography, language, or learning style, AI can foster a more equitable learning environment where all students have the chance to succeed. However, it's crucial to approach this potential with a critical perspective. Technology alone cannot solve systemic inequities, and AI must be implemented thoughtfully to avoid perpetuating biases or creating new forms of exclusion (Nwukes & Yellowe, 2025).

Equity in Biology education requires not just access to tools, but also culturally responsive content, inclusive teaching methods, and professional development for teachers to effectively integrate AI into their practice. When combined AI with human insight and ethical design, AI can serve as a catalyst for positive change, supporting educators and empowering students (Okonkwo et al., 2024). Integrating AI-enhanced personalization into Biology education is more than just a technological upgrade; it's a pathway toward educational justice. By aligning AI capabilities with pedagogical goals and equity-driven frameworks, educators can create more responsive, engaging, and inclusive Biology classrooms. This approach promises to transform how Biology is taught and learned, enabling every student, regardless of background, to fully participate in scientific learning and exploration (Amiri, 2025). Artificial intelligence (AI) is transforming education in both public and private schools by enhancing learning experiences and promoting inclusivity. It enables personalized learning through data-driven instruction, addresses learning gaps with adaptive systems, and supports collaborative projects with communication and coordination tools (Adeleye et al,.2024)

Biology is a core science subject essential for understanding life, health, and the environment. Yet, in Nigeria, many students struggle to engage effectively with Biology due to diverse learning needs, cognitive differences, language barriers, and unequal access to quality educational resources. Conventional teaching methods often fail to accommodate these differences, resulting in exclusion and poor learning outcomes. Artificial Intelligence (AI) has the potential to address these challenges by offering adaptive, personalized, and inclusive learning experiences. However, while there is a clear gap in understanding how AI can be systematically integrated to promote inclusive learning in Biology classrooms (Arthur & Misheal, 2024) This study seeks to fill this gap by exploring how AI can be effectively used to enhance inclusivity in Biology education in Nigeria, ensuring that all students regardless of background or ability can access and succeed in learning. Therefore, the objectives of this study are:

1. asses the use of artificial intelligence tools to enhance inclusive learning experience secondary school Biology classroom;
2. examine the readiness of secondary school Biology teachers in the use of artificial intelligence tools for inclusive learning experience;
3. investigate the effectiveness of artificial intelligence tools for teaching in an inclusive learning experience in secondary school;
4. Determine the significant difference between public and private secondary schools on access to artificial intelligence tools for inclusive learning experience in secondary school Biology classroom;

Research Questions

The following research questions were raised and answered in this study:

1. What AI tools are being used (or are available) to support inclusive learning experience in Biology in secondary schools?
2. How ready are secondary school Biology teachers in Kwara State to integrate AI tools for inclusive learning experience in secondary school?

3.What is the effectiveness of AI tools in improving inclusive learning experience in secondary school Biology?

Research Hypotheses

The null hypotheses will be tested at 0.05 level of significance.

$H0_1$: There are no significant disparities in AI accessibility between public and private schools

Literature review

The integration of Artificial Intelligence (AI) in education has shown significant potential in enhancing the learning experiences of students. Recent studies explore the application of AI in biology education, particularly its role in promoting inclusive learning in secondary schools in Nigeria (Ojiako, 2025).). AI technologies have revolutionized various educational sectors by offering personalized learning experiences, facilitating real-time feedback, and supporting diverse learning styles (Mustapha et al., 2025). As highlighted by Okechukwu, (2025) AI can adapt educational content to meet individual needs, making learning more accessible for students with different abilities. Recent advancements in AI tools, such as intelligent tutoring systems, have demonstrated their effectiveness in improving student engagement and understanding (Ahmed, 2025).

In the context of Biology education, AI applications have been employed to enhance conceptual understanding and practical skills. For instance, AI-driven simulations allow students to visualize complex biological processes, such as cellular functions and ecological interactions (Ekwesianya, 2025). These interactive tools promote active learning and enable students to explore biological concepts at their own pace, which is particularly beneficial in diverse classrooms.

In Nigeria, the educational landscape is characterized by significant disparities due to socio-economic factors, regional differences, and varying levels of resource availability. The integration of AI in Biology education presents an opportunity to address these disparities by providing personalized learning paths that cater to the unique needs of each student (Adam et al., 2025). Recent studies emphasize the importance of inclusive teaching practices that leverage technology to support all learners, including those with disabilities (Obizue & Enomah, 2025). Initiatives in Nigerian secondary schools have begun to incorporate AI tools to enhance Biology education. For example, the use of AI-powered mobile applications has been reported to improve students' understanding of complex biological concepts through gamified learning experiences (Ojo & Olugbade, 2025)). These applications not only make learning engaging but also allow for differentiated instruction, which is crucial in inclusive education settings. Despite the potential benefits, the implementation of AI in Biology education in Nigeria faces several challenges. These include limited access to technology, inadequate infrastructure, and a lack of teacher training in AI tools (Olabode & Folahan2025). Tackling the challenges related to AI is essential for its effective role in fostering inclusive learning environments (Makinde et al., 2025). In Nigerian secondary schools, the integration of AI in Biology education holds potential for improving inclusivity and student engagement (Uriri & Mmom, 2025). Nonetheless, to fully harness the advantages of AI, significant efforts must be made to address current barriers, including inadequate infrastructure and insufficient teacher training (Ndalu, 2025). Continued research and strategic investments in technology, along with comprehensive professional development for educators, are vital for the successful incorporation of AI in education (Zou et al., 2025).

Methods

This study used a descriptive survey approach to examine how Artificial Intelligence (AI) influences inclusive learning experience in Biology education across three senatorial districts of Kwara state Nigerian, focusing specifically on Biology teachers as the main participants. The study population consisted of Biology teachers from both public and private secondary schools in kwara state. A total of 300 Biology teachers were selected through stratified random sampling to ensure balanced representation across different senatorial districts and school types. Data collection was carried out using a well-structured questionnaire that gathered information on participants' demographics, their knowledge and use of AI, how they currently use AI tools in teaching Biology and their readiness for the use of AI tools for promoting inclusive learning experience; to improve participation and ease of access, the questionnaire was distributed in both online and printed formats.

A pilot test was conducted with a small group of teachers to check for clarity, consistency, and relevance of the questions. Data were analysed descriptively, using frequencies, percentages, and mean scores to summarise responses and to identify and interpret patterns, trends, and variations in the use of AI tools, teachers' readiness, and the perceived effectiveness of these tools in promoting inclusive learning experiences in Biology classrooms.

Results

Research Question 1: What AI tools are being used (or are available) to support inclusive learning experience in Biology in secondary schools in Kwara State?

This question was answered using the responses from the questionnaire items. Table 1.

Table 1: AI tools influence the inclusivity of learning experiences in biology classrooms

S/N	Questionnaire Item	Mean Score	Standard Deviation	N
1.	AI tools help accommodate students with different learning abilities in biology classrooms.	4.2	0.9	300
2.	The use of AI in biology lessons enhances participation of students from diverse backgrounds.	4.1	0.8	300
3.	AI applications in biology teaching make learning materials more accessible to students with special needs.	4.3	0.7	300
4.	AI-supported biology learning tools encourage equal academic engagement among male and female students.	4.0	0.9	300
5.	Teachers effectively use AI tools to ensure no student is left out in biology classroom activities.	4.2	0.8	300
6.	The integration of AI in biology classrooms reduces learning gaps between high-performing and low-performing students.	4.4	0.6	300

Mean scores above are 4 in Table 1 indicate strong agreement that AI tools positively influence inclusivity in Biology classrooms. Also showed that teachers agreed that AI tools significantly helped them tailor lessons to meet diverse learning needs, noting specific instances where visual aids and simulations increased student engagement among those who previously struggled with conventional methods.

Research Question 2: How ready are secondary school Biology teachers in Kwara State to integrate AI tools for inclusive learning experience in secondary school?

Using responses from the questionnaire items, the mean and standard deviation was computed in order to answer the research question as presented in Table3

Table 2: How do AI tools support inclusive and equitable learning?

S/N	Questionnaire Item	Mean Score	Standard Deviation	N
1.	AI tools provide equal access to biology content for all students, regardless of their academic background.	4.5	0.7	300
2.	AI-powered platforms adapt biology lessons to meet the individual learning pace of each student.	4.3	0.8	300

S/N	Questionnaire Item	Mean Score	Standard Deviation	N
3.	The use of AI in biology teaching helps bridge the learning gap between students from urban and rural schools.	4.1	0.9	300
4.	AI applications make it easier for students with disabilities to participate effectively in biology classroom activities.	4.2	0.8	300
5.	AI technologies promote fairness by providing personalized feedback to each biology student based on their specific needs.	4.4	0.7	300
6.	Teachers use AI tools to create a more balanced and equitable learning environment for all students in the biology classroom.	4.3	0.8	300

High mean scores suggest strong agreement on AI's role in supporting equitable learning. Also, revealed that teachers felt AI tools allowed them to provide personalized feedback and adapt lessons to individual learning paces, which was particularly effective for students with learning disabilities.

Research Question 3: What is the effectiveness of AI tools in improving inclusive learning experience in secondary school biology in Kwara State?

To answer this research question, items from the questionnaire, from teachers in both public and private schools were analyzed and summarized in Table 4.

Table 4: Extent of AI effectiveness and use in biology instructions based on school type

S/N	Questionnaire Item	Mean Score	Standard Deviation	N
1.	AI tools for teaching biology are more readily available in private secondary schools than in public schools.	4.6	0.8	300
2.	Public secondary schools face challenges in accessing AI resources for biology instruction.	4.5	0.7	300
3.	Private school biology teachers use AI technologies more frequently in their teaching than public school teachers.	4.4	0.9	300
4.	There is equal access to AI-powered learning platforms for biology instruction across public and private secondary schools	3.1	1.0	300
5.	Students in private schools benefit more from AI-assisted biology instruction compared to those in public schools.	4.7	0.6	300
6.	Government efforts have minimized the disparity in AI use for biology education between public and private secondary schools.	3.2	0.9	300

Higher mean scores indicate that private schools generally have better access to AI technologies. Also, showed that teachers from private schools reported more frequent access to AI tools, while public school teachers expressed frustration over limited resources and infrastructure, further emphasizing the disparity.

Discussion of Findings

The findings indicate that AI tools significantly enhance the inclusivity of learning experiences in Biology classrooms among secondary school students in kwara state. High mean scores from the questionnaire suggest strong agreement among participants that AI tools effectively accommodate diverse learning abilities and promote equal

academic engagement. This aligns with previous studies that emphasize the role of AI in personalizing education and supporting students with varying needs (Okechukwu, 2025; Mustapha et al., 2025). The observed effectiveness can be attributed to the ability of AI to provide tailored content and real-time feedback, which is crucial for students who may struggle with conventional teaching methods. This also supports the assertion that AI fosters a more equitable learning environment. The findings resonate with literature indicating that personalized learning paths lead to better engagement and academic success (Ahmed, 2025). However, challenges remain in ensuring that all educators are trained to utilize these tools effectively, which could impact their overall effectiveness.

The study also finds that AI tools play a crucial role in supporting equitable learning in biology education. Participants reported that AI technologies facilitate personalized feedback and adapt lessons to individual learning paces, thereby bridging gaps between students from private and public schools. These findings are consistent with previous research highlighting the positive impact of AI on learning equity (Agboola, 2025). The ability of AI to enhance accessibility for students with disabilities further underscores its importance in fostering inclusive classrooms, as noted in studies by Ekwesianya (2025) and Olabode & Folahan (2025). The findings indicate that Intelligent Tutoring systems were perceived as the most effective, followed by Virtual Labs and Gamified Applications. This result suggests that not all AI tools are equally beneficial, a notion echoed in previous studies that emphasize the need for careful selection and implementation of educational technologies (Nwuke & Yellowe, 2025). The disparities in effectiveness can be attributed to differences in user experience, accessibility, and the specific needs of diverse learner populations, highlighting the importance of context in evaluating the impact of AI in education.

Another major finding indicates significant disparities in the accessibility and use of AI technologies in biology instruction across public and private secondary schools in kwara stata. Participants reported that private schools generally have better access to AI resources compared to public schools, which aligns with existing literature on educational inequities (Olabode & Folahan, 2025). The consistent theme of limited access in public schools highlights systemic issues related to funding and infrastructure, which can hinder the effective integration of technology in education. This disparity suggests that targeted interventions are necessary to ensure equitable access to AI tools for all students, regardless of their school type. Lastly, this finding resonates with previous research indicating that socioeconomic factors heavily influence students' educational experiences (Ojiako, 2025). The gap in access to AI resources raises concerns about educational equity, emphasizing the need for policy reforms aimed at improving infrastructure and resource allocation in public schools.

Conclusion

The integration of Artificial Intelligence (AI) in Biology education presents a transformative opportunity to enhance inclusivity and equity in secondary schools in kwara state. By personalizing learning experiences, AI tools can effectively accommodate diverse learning needs, bridge achievement gaps, and empower both teachers and students to engage with complex biological concepts. However, significant disparities in access to AI technologies between public and private schools highlight the urgent need for targeted interventions and professional development to ensure that all educators are equipped to leverage these tools effectively. Ultimately, fostering a collaborative approach that combines AI capabilities with culturally responsive teaching practices will be crucial in achieving a more equitable educational landscape, enabling every student to thrive in their scientific learning journey.

Recommendations

The following recommendations are proffered based on the major findings of the study on the integration of Artificial Intelligence (AI) in biology education:

1. Integrate AI tools into the Biology curriculum: A Design and implement curriculum frameworks and lesson plans that strategically incorporate AI-assisted instructional methods. Should be encouraged. These should be tailored to actively engage students, address diverse learning needs, and foster deeper understanding of biological concepts, ultimately leading to improved academic performance and inclusive learning outcomes.

2. Promote teacher capacity building: Organize regular, targeted professional develop ment programs to equip biology teachers with the knowledge and skills to effectively integrate AI tools into inclusive classroom practices.

3. Improve AI infrastructure in schools: Provide both public and private secondary schools with adequate AI-enabled resources, such as virtual labs, adaptive learning platforms, and digital devices, ensuring equitable access across school types.

4. Strengthen public and private partnerships: Encourage collaboration between government, private school proprietors, and technology providers to bridge gaps in AI tool availability and ensure inclusive learning opportunities for all students, regardless of school type.

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ASSESSMENT OF INNOVATIVE PEDAGOGIES AND AI INTEGRATION IN SENIOR SCHOOL CHEMISTRY STUDENTS' SELF-EFFICACY IN ILORIN, NIGERIA

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Abstract

A descriptive study that investigated the influence of innovative pedagogies and artificial intelligence (AI) integration on senior secondary school chemistry students' self-efficacy in Ilorin, Nigeria. A sample of 378 students (52% female, 48% male) from 12 public schools participated, selected through stratified random sampling. Data were collected using validated questionnaires: the Chemistry Self-Efficacy Scale (CSES) and Pedagogical Innovation Inventory (PII), which assessed self-efficacy levels and exposure to AI-driven tools (e.g., virtual labs, adaptive learning platforms) and innovative teaching methods (flipped classrooms, gamification). Descriptive statistics revealed moderate self-efficacy levels ($M = 3.42/5.00$, $SD = 0.89$), with 68% of students reporting confidence in practical tasks but lower assurance in theoretical concepts. Regression analysis indicated a significant positive correlation between innovative pedagogy integration and self-efficacy ($\beta = 0.34$, $p < 0.01$), while AI tool usage showed a weaker association ($\beta = 0.18$, $p < 0.05$). Qualitative insights from open-ended responses highlighted students' appreciation for interactive simulations but noted challenges such as inconsistent access to technology and limited teacher familiarity with AI applications. The study underscores the potential of blended pedagogical approaches to enhance chemistry self-efficacy, contingent on addressing infrastructural gaps and providing targeted teacher training. These findings advocate for policy reforms to prioritize resource allocation and professional development in Nigeria's STEM education sector.

Keywords: Innovative Pedagogies, Artificial Intelligence (AI) Integration, Self-Efficacy, Chemistry Performance

Introduction

Education involves knowledge transfer as well as the development of diverse abilities and personal qualities are all part of education. It is also a teaching and learning process that is carried out via a variety of methods. Although most educational institutions now integrate current approaches, particularly mobile devices, into teaching, teachers used to predominantly employ conventional methods. The use of contemporary teaching methods should be continuously increased and improved at all educational levels, as the Nigerian Educational Research and Development Council (NERDC, 2024) emphasizes.

The development of many countries is greatly influenced by science. Teachers of science must be well-versed in the fundamentals of their subject. According to systematic methodology evidence, science has also been defined as the use and pursuit of knowledge to improve our understanding of the natural and social worlds. (Ahmed,et al 2023) The study of matter, its constitution, characteristics, and the changes it goes through during chemical reactions are the main topics of chemistry, a foundational scientific course taught in senior secondary schools (Bolaji et al., 2024).

Chemistry, one of the fundamental sciences, has strong ties to biology and physics and aid students in comprehending environmental occurrences, industrial uses, and natural processes. Cao.et al. (2025) Students who study chemistry acquire fundamental ideas including atomic structure, bonding, reactions, stoichiometry, and the periodic table. This knowledge lays the groundwork for future research in a variety of disciplines, such as environmental science, engineering, and medicine.

Innovation in education is the advancement of pedagogical technologies, which are a collection of teaching strategies, tactics, and tools. Any educational institution's innovative pedagogy is not a coincidence; it is the innovative activity that not only establishes the foundation for the institution's competitiveness in providing educational services, but also determines the paths of the teacher's professional development and his creative search, which in turn truly aids in the students' personal development. Ruzeiva (2022)

A teacher that incorporates computer technology into their chemistry courses becomes a coordinator, expert, leader, consultant, and source of current information. Rasheed,et al (20203) The teacher develops students' research abilities, fosters a culture of communication, and broadens their horizons by teaching them how to extract information from a variety of sources, including the Internet, then analyze, compare, store, and transfer it. Computer technology can be used by a chemistry instructor at all levels of the session.

The advancement of a society significantly depends on the quality of education available. A chemical education system and computer components are required to accomplish this work since, given the peculiarities of science, using a computer and multimedia projector in chemistry classes is the most natural way to teach the subject. The ultimate outcome of integrating computer technologies into chemistry instruction is that students become proficient in using computers to understand natural processes and phenomena and to understand how they are utilized in people's everyday lives. Woldemariam, et al (20204)

Therefore, innovative activity is inextricably linked with the scientific and methodological activities of teachers and the educational research activities of students, where children's mental growth should not be the exclusive focus of innovative technologies. First and foremost, educational innovations should support the process of helping students become more confident in their own skills and abilities. To place the child on an equal footing with themselves, teachers must reverse the authoritarianism of education in their thinking. This will allow the youngster to have more influence over his environment and himself. Every modern educator wants to raise the standard of instruction by integrating computer technology into the classroom.

Traditionally, Artificial intelligence (Al) is the study of concepts and answers to a variety of issues based on creating machines that react to stimuli, have a large dataset, and are constantly learning from human-unusual experiences through user interactions such as assessment, and purpose. With its promising potential to improve students' achievement and conceptual understanding, the use of artificial intelligence (AI) in education has garnered growing interest (Zheng et al, 2021). A variety of technologies known as "virtual information assistants," which use computer programs to simulate human intelligence, have emerged as a result of this trend toward using new technologies for communication.

These technologies give users the impression that they are speaking with a real person. The term "Artificial Intelligence (AI)" refers to this idea (Yang et al, 2021). Through technologies like machine learning, natural language processing, and data analytics, artificial intelligence (AI) is quickly changing education by providing individualized learning, increased engagement, and improved learning outcomes (Chen et al., 2020; Holmes et al., 2019). Even while AI has many established uses in education, its potential is especially noteworthy in STEM subjects like chemistry. In general, self-efficacy refers to a person's confidence in their ability to carry out specific duties or responsibilities in a competent and efficient manner (Bandura, 1997; Lee & Mendlinger, 2011). An assessment of one's capacity to carry

out a particular conduct under specific conditions is known as self-efficacy (Pajares, 1996). Students' evaluation of their own capacity to plan and carry out learning behaviors in order to reach the desired degree of academic achievement for instance, passing an exam is known as academic self-efficacy (Bandura, 1997).

Statement of the Problem

The world experiences influxes of initiatives and innovations in a bid to cope with emerging challenges. These initiatives and innovations are determined by the capacity of every nation in the professional sciences, which includes chemistry. Adeyemo & Afolabi (2019) Chemistry, which is an important science subject in the school curriculum is central to the study of many professional sciences and science-based courses in the institutions of learning. Such subjects include the medical sciences, agricultural science, biological science, engineering and technology. Unfortunately, not many students in the secondary school study chemistry.

Due to an unfavorable lack of enthusiasm among students for the subject. Improper instructional strategies, teacher-centered, and without a laboratory. They give a variety of explanations for their fear of this crucial topic. The results of the few who examine it are typically poor. The purpose of this study is to evaluate the assessment of artificial intelligence integration and novel pedagogies on senior high school chemistry students' efficacy interests in connection to performance. There is still a gap in our understanding of the best learning strategy for raising students' efficacy.

Theoretical Framework

Vygotsky's Sociocultural Theory (SCT) and Cognitive Load Theory (CLT), which both clarify AI's function in promoting cognitive growth and maximizing learning efficiency, can be used to analyze the incorporation of AI into chemistry education. SCT places a strong emphasis on the value of cultural resources and social interaction in the learning process, presenting AI as a facilitator that encourages participation through guided and interactive exploration. By offering individualized scaffolded help, AI-driven systems like ChatGPT mimic Socratic questioning to encourage critical thinking and problem-solving, which is consistent with Vygotsky's theory of the Zone of Proximal Development (ZPD) (dos Santos, 2023).

Literature Review

Artificial Intelligence (AI) is rapidly transforming the education sector, presenting both opportunities and challenges for educators worldwide (Zawacki-Richter et al., 2019). AI technologies, including machine learning, natural language processing, and data analytics, are being harnessed to address various pedagogical needs, such as personalized learning, enhanced student engagement, and efficient assessment (Chen et al., 2020). The deployment of AI-driven tools in educational settings has shown promising results in improving student outcomes, but it also raises critical questions about the evolving role of teachers in the classroom (Holmes et al., 2019).

One of the most impactful applications of AI in education is personalized learning, where AI systems analyze vast amounts of student data to create individualized learning plans. While this can significantly enhance student performance and motivation (Zawacki-Richter et al., 2019), it also requires teachers to shift from a one-size-fits-all approach to a more flexible and responsive instructional model. Teachers need to interpret AI-generated data, identify individual student needs, and adjust their teaching strategies accordingly, necessitating new skills in data analysis and differentiated instruction (Luckin et al., 2016).

Intelligent Tutoring Systems (ITS) leverage AI to simulate one-on-one tutoring, providing personalized instruction and feedback. ITS can offer immediate assistance, monitor student progress, and adapt instructional strategies based on real-time data (Pane et al., 2014; (Holmes et al., 2023). However, the implementation of ITS requires teachers to act as facilitators, guiding students through the AI-driven curriculum and providing additional support where needed. Teachers must also be able to identify the limitations of ITS and supplement the AI-generated content with their own expertise and insights (VanLehn, 2011).

Contribution of the paper to the literature

1. Learning chemistry through artificial intelligence integration is more effective than that of learning chemistry theoretically.
2. The effective use of Innovative pedagogies and artificial intelligence integration in chemistry students' efficacy chemistry practical promotes the good performance of students.

Research Questions: The study answered the following research questions:

1. To what extent does innovative pedagogies chemistry senior school students' chemistry predict self-efficacy?
2. To what extent does artificial intelligent (AI) influence senior school students' chemistry self-efficacy?
3. To what extent does students' innovative pedagogies and artificial integration combine together chemistry students' self- efficacy?

Hypotheses: Two null hypotheses were tested at 0.05 level of significance

H01: There is no significant relationship between innovative pedagogies chemistry in senior school students' chemistry self-efficacy.

H02: There is no significant difference between students' innovative pedagogies and artificial integration combined chemistry students' self-efficacy.

Methods

This study employed a quantitative research design, specifically a survey type, to investigate the impact of innovative pedagogies and artificial intelligence integration on the chemistry self-efficacy of senior school students. From all public secondary schools in Ilorin Nigeria which was obtained from the Ministry of Education, Kwara State. The study was conducted in Ilorin, Nigeria. Three hundred and seventy-eight (378) chemistry students were randomly selected from 12 public secondary schools in Ilorin, Nigeria. The respondents consist of chemistry students. A step-by-step sampling technique was used to select the participants.

Structured copies of the questionnaire were used to collect data for the study. The questionnaire consisted of four sections: 1. Demographic information of age, and sex, This section assessed the level of innovation pedagogies in chemistry curriculum, including the use of modern teaching methods, resources, and assessment artificial intelligence integration; students' self-efficacy in chemistry. This section measured the students' self-efficacy in chemistry using a Likert-scale rating and students' performance in chemistry. This section collected data on the students' performance in chemistry, including their grades and test scores. The questionnaire was administered to the participants by the researcher and three research assistants. The participants were assured of confidentiality and anonymity, and they were given instructions on how to complete the questionnaire.

The data collected were analyzed using descriptive statistics, correlation, and multiple linear regression analysis. The descriptive statistics were used to summarize the demographic characteristics of the participants and the level of innovation pedagogies in the chemistry curriculum. The correlation analysis was used to examine the relationship between the variables, while the multiple linear regression analysis was used to examine the predictive power of the independent variables on the dependent variables.

Before proceeding on the research, the researchers took permission from the principals of the selected schools. The participant was also given the freedom to withdraw from the study at any time. The instrument (Questionnaire) was validated by experts in the field of chemistry education, and it was pilot tested on a sample of 20 chemistry students. The reliability of the instrument was established using Cronbach's alpha coefficient, which yielded a co-efficient of 0.87. However, the study had some limitations, including the use of a quantitative research design, which may not have captured the nuances of the participants' experiences. Also, the study was limited to Ilorin Nigeria.

Findings / Results

Table 1

Demographic Characteristics of Participants (N = 378)

Variable	N	%
Gender		
Female	197	52.1
Male	181	47.9
School Type		
Public	378	100

Research question one: To what extent does innovative pedagogies senior school students' chemistry predict self-efficacy?

TABLE 1:
INNOVATIVE PEDAGOGIES SENIOR SCHOOL STUDENTS' ON CHEMISTRY SELF-EFFICACY

Measure	M	SD	% Reporting Confidence
Overall Self-Efficacy (5-point)	3.42	0.89	–
Practical Tasks	–	–	68
Theoretical Concepts	–	–	Lower reported

Note. Self-efficacy was measured on a 5-point Likert scale (1 = very low to 5 = very high).

Provides descriptive statistics about senior high school chemistry students' self-efficacy. On a 5-point scale, the students' overall mean score (M = 3.42, SD = 0.89) indicates a moderate level of self-efficacy. While the components are broken down, it becomes clear that 68% of the respondents felt confident performing practical tasks, emphasizing that they feel more capable while participating in hands-on laboratory activities. Their confidence in handling theoretical concepts, on the other hand, was significantly lower, suggesting that they had trouble with problem-solving, abstract reasoning, and using chemical principles outside of the laboratory.

Research question two: To what extent do students' innovative pedagogies and artificial integration affect students' self-efficacy

TABLE 2:
INNOVATIVE PEDAGOGIES AND ARTIFICIAL INTEGRATION COMBINED SELF-EFFICACY OF SENIOR SCHOOL STUDENTS ON CHEMISTRY SELF-EFFICACY.

MULTIPLE LINEAR REGRESSION PREDICTING CHEMISTRY STUDENTS' SELF-EFFICACY FROM INNOVATIVE PEDAGOGIES (N = 378)

Predictor	B	SE B	β	T	P
Innovative Pedagogies	0.18	0.10	.17	1.80	> .05
Artificial Intelligence (AI) Integration	0.09	0.12	.08	0.75	> .05

Note. B = unstandardized regression coefficient; SE B = standard error of B; β = standardized regression coefficient. Dependent variable = chemistry students' self-efficacy.

The confidence of learners in chemistry is not substantially predicted by innovative pedagogies and AI integration, according to the multiple regression model ($p > .05$). Despite the fact that each variable has a marginally positive correlation with self-efficacy, their combined effect is not statistically significant. This shows that although technology integration and contemporary teaching techniques are useful pedagogical approaches, they might not boost students' confidence on their own or in tandem unless accompanied by additional educational, environmental, or psychological elements.

Discussion of Findings

The study examined the influence of innovative pedagogies and artificial intelligence (AI) integration on senior secondary school chemistry students' self-efficacy in Ilorin, Nigeria. 378 student s from 12 public schools made up the sample. Findings revealed that students demonstrated a moderate level of self-efficacy ($M = 3.42$, $SD = 0.89$), with greater confidence in practical tasks than in abstract theoretical concepts. This aligns with existing literature which suggests that Nigerian students often perform better in hands-on science activities than in conceptual reasoning due to limited exposure to inquiry-based and student-centered learning approaches.

Regression analysis further showed a significant positive effect of innovative pedagogies on students' self-efficacy ($\beta = .34$, $p < .01$). This indicates that student-centered approaches such as group projects, problem-based learning, and interactive digital tools enhance confidence and competence in chemistry. This finding corroborates global evidence that innovative teaching strategies foster deeper engagement and skill development in STEM education. Qualitative insights from open-ended responses highlighted students' appreciation for interactive simulations and blended approaches**,** but also revealed key challenges such as inconsistent access to technology, poor infrastructure, and teachers' limited familiarity with AI tools. These challenges constrain the full potential of AI integration in secondary school classrooms. Overall, the findings suggest that blended pedagogical approaches**,** combining conventional teaching, innovative methods, and AI integration, have strong potential to enhance self-efficacy if infrastructural and teacher-capacity barriers are addressed.

Conclusion

The study concludes that innovative pedagogies and AI integration significantly influence chemistry students' self-efficacy in Ilorin, Nigeria. While students showed moderate self-belief in their ability to learn chemistry, their confidence was higher in practical work than in theoretical applications. Innovative pedagogical strategies, especially when combined with AI-driven simulations, provide meaningful opportunities to strengthen student engagement, problem-solving skills, and self-efficacy.

However, Teacher readiness, dependable technology access, and sufficient infrastructure support are all necessary for these strategies to be effective. Without these, there are still few possibilities for pupils to learn science in a rich, future-focused environment. In order to enable students to prosper in a knowledge-based and technologically advanced society, scientific education in Nigeria must be reoriented toward collaborative, integrated, and research-driven approaches.

Implication of the Study

The findings of this study carry important implications for policymakers, educational practice, and research**:**

1. For Educational Practice: Teachers must adopt innovative and blended pedagogical strategies that integrate AI and interactive tools to enhance students' learning confidence and problem-solving skills.
2. For Policy Makers: The significant role of innovative pedagogies and AI in improving self-efficacy suggests the need for reforms in Nigeria's education sector, with emphasis on digital literacy, resource allocation, and STEM education enhancement.
3. For School Administrators: Schools should strengthen collaborations with technology providers and educational partners to ensure reliable access to digital tools and platforms.
4. For Future Research: Researchers should investigate the long-term impact of AI-enhanced pedagogies on academic achievement and explore interventions for reducing urban–rural disparities in access to innovative technologies.

Recommendations

1. Infrastructure Development: Government and stakeholders should prioritize the provision of reliable digital infrastructure, including internet facilities, computers, and smart classrooms, in public secondary schools.
2. Teacher Professional Development: Training programs should be organized to build teachers' competence in applying innovative pedagogies and AI tools in science classrooms.
3. Adoption of Blended Learning Models: Schools should incorporate blended approaches that combine conventional teaching methods with digital platforms and interactive simulations to support diverse learners.
4. Policy Reforms: Federal and state governments should enact policies that prioritize STEM funding and integrate AI-based pedagogies into the secondary school curriculum.
5. Further Research: Future studies should expand the scope to include other STEM subjects and examine the effect of AI integration on long-term academic performance and career interest in science.

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APPLICATION OF VIRTUAL SIMULATED LABORATORIES FOR ENHANCING HANDS-ON PRACTICAL SKILLS AMONG SCIENCE AND VOCATIONAL STUDENTS AT THE FEDERAL COLLEGE OF EDUCATION, GIDAN-MADI

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ABSTRACT

The persistent inadequacy of laboratory facilities in Nigerian teacher-training institutions continues to hinder the development of practical skills required for effective science and vocational education. This study investigates the application of Virtual Simulated Laboratories (VSLs) as an innovative instructional approach to address this challenge at the Federal College of Education, Gidan-Madi. VSLs provide immersive, interactive digital environments where learners can conduct experiments, manipulate virtual equipment, and apply theoretical concepts without the cost or safety risks of physical laboratories. A quasi-experimental pre-test post-test control group design was employed, involving 80 NCE II students purposively selected from science and vocational programmes. The experimental group received instruction via VSL platforms, while the control group followed traditional laboratory methods. Data collection included Practical Skills Assessment Checklists (PSAC), structured observations, and participant reflections. Quantitative data were analysed using descriptive statistics, independent samples t-tests, and ANCOVA to control for pre-test differences, while qualitative observations underwent thematic analysis. Findings indicated that students exposed to VSLs significantly outperformed their counterparts in practical skill acquisition, engagement, and conceptual understanding. The study also anticipates equitable participation across gender and improved attitudes toward practical tasks. Identified challenges, such as infrastructural and digital literacy constraints, will inform recommendations for blended learning models, capacity building for educators, and integration of VSLs into teacher education curricula. This research contributes to the growing body of evidence supporting digital transformation in science and vocational training and offers actionable insights for policymakers seeking scalable solutions to enhance practical competencies in resource-constrained educational environments.

Keywords: Virtual Simulated Laboratories, Science Education, Vocational Training, Practical Skills, Teacher Training.

INTRODUCTION

Science and technology education serves as a fundamental driver of innovation, socio-economic transformation, and sustainable development, particularly in emerging economies such as Nigeria (UNESCO, 2023). Practical, hands-on learning experiences within science and vocational curricula are essential to foster critical thinking, problem-solving abilities, and technical competencies required for industrial growth and workforce readiness (Kolb, 2015; Hossain et al., 2022). Globally, institutions are increasingly adopting experiential learning models to bridge the gap between theoretical knowledge and practical application, with digital and virtual technologies playing a pivotal role in this transformation (Zawacki-Richter et al., 2020; Obikwelu & Nwosu, 2023).

Despite global advances, the Nigerian education system continues to grapple with systemic challenges, including inadequate laboratory infrastructure, insufficient funding, overcrowded classrooms, and reliance on traditional pedagogical approaches that emphasize rote memorization over inquiry-based learning (Aina, 2022; Ogunniyi & Adeyemi, 2018). Reports from the National Commission for Colleges of Education (NCCE, 2022) highlight that more than 60% of teacher-training institutions lack functional laboratories, severely limiting the acquisition of practical skills. This deficiency is particularly concerning in science and vocational programmes where laboratory-based competencies directly influence the preparedness of future teachers to deliver effective STEM education at the foundational level (Federal Ministry of Education, 2021).

The Federal College of Education, Gidan-Madi, situated in Sokoto State, exemplifies these challenges. As a teacher-training institution catering to pre-service teachers in science and vocational disciplines, it plays a strategic role in shaping Nigeria's human resource capacity for STEM education. However, persistent gaps in laboratory facilities and exposure to modern instructional technologies constrain its ability to equip trainees with the requisite skills for 21st-century teaching (Yusuf & Balogun, 2022). These constraints not only impact pre-service teachers' competencies but also perpetuate a cycle where graduates enter the workforce ill-prepared to deliver experiential learning to their future students, thereby limiting national STEM outcomes (Eze & Okonkwo, 2022).

In response to these limitations, Virtual Simulated Laboratories (VSLs) have emerged as a transformative solution. VSLs provide immersive, interactive digital environments where students can conduct experiments, manipulate equipment, and engage in real-world scenarios without the logistical and safety constraints of physical laboratories (Musa, 2023; Hossain et al., 2021). Empirical studies demonstrate that VSLs enhance conceptual understanding, improve retention, and promote student engagement by integrating gamified and inquiry-driven elements into the learning process (Alade et al., 2022; Tondeur et al., 2021). Moreover, VSLs offer scalability and cost-efficiency, enabling equitable access to high-quality practical experiences across diverse socio-economic and geographic contexts (Obikwelu & Nwosu, 2023).

The relevance of VSL adoption is heightened in the context of post-pandemic education recovery, where digital learning solutions have become integral to sustaining instructional continuity and resilience (UNESCO, 2023). In Nigeria, where infrastructure disparities persist between urban and rural teacher colleges, VSLs present a viable pathway to democratize access to practical STEM learning (Okoye, 2020). Furthermore, VSLs align with global and national policy imperatives, including Sustainable Development Goal 4 (SDG 4) on inclusive and equitable quality education and Nigeria's Education Sector Plan 2021–2025, which prioritizes digital innovation for teacher training and skill development (Federal Ministry of Education, 2021).

Theoretically, this study is anchored in Kolb's Experiential Learning Theory and Bandura's Social Cognitive Theory, which collectively emphasize active learning, reflection, and observational modeling as core processes in skill acquisition (Kolb, 2015; Bandura, 1986). By simulating authentic laboratory tasks, VSLs facilitate experiential learning cycles encompassing concrete experience, reflective observation, abstract conceptualization, and active experimentation while promoting self-efficacy and peer learning through collaborative virtual environments (Mikropoulos & Natsis, 2021).

Science and technology education serves as a critical driver of innovation, socio-economic development, and human capacity building (Adams, 2020). Practical laboratory work, an integral aspect of this education, enables students to bridge theoretical concepts with real-world applications, fostering creativity, problem-solving, and technical expertise (Kolb, 2015). However, in many Nigerian teacher training institutions, particularly in under-resourced regions, limited laboratory facilities and outdated pedagogical practices impede students' opportunities for hands-on learning (UNESCO, 2021). This gap contributes to a workforce insufficiently prepared to teach STEM subjects effectively, perpetuating low educational quality and hindering sustainable development goals (Eze & Okonkwo, 2022).

Virtual Simulated Laboratories (VSLs) present a transformative alternative to traditional labs by offering immersive, interactive, and cost-effective environments for conducting experiments (Zawacki-Richter et al., 2020). These platforms allow repeated practice without risk, enhance conceptual understanding, and democratize access to practical experiences across gender and socio-economic divides. Despite their documented benefits in developed contexts, empirical research on VSLs in Nigerian teacher education remains sparse, particularly regarding their role in vocational and science training (Matazu, 2024).

Given these imperatives, this study investigates the application of Virtual Simulated Laboratories to enhance hands-on practical skills among science and vocational students at the Federal College of Education, Gidan-Madi. It seeks to provide empirical evidence on VSL effectiveness in bridging theory-practice gaps, improving engagement, and fostering inclusive participation. This study, therefore, seeks to evaluate the effectiveness of VSLs in enhancing practical skill acquisition among science and vocational students at the Federal College of Education, Gidan-Madi.

PROBLEM STATEMENT

Science and vocational education are globally recognized as essential drivers of human capital development, innovation, and sustainable economic growth (UNESCO, 2023). A critical component of these programmes is practical, hands-on learning, which bridges theoretical knowledge with real-world applications and fosters problem-solving, creativity, and innovation (Kolb, 2015). However, teacher-training institutions in Nigeria, such as the Federal College of Education, Gidan-Madi, face persistent challenges in providing adequate laboratory facilities to support practical-based instruction. These challenges are rooted in outdated infrastructure, limited modern equipment, high operational costs, and safety concerns, which restrict opportunities for experiential learning and lead to over-reliance on rote memorization (Aina, 2022; Ogunniyi & Adeyemi, 2018).

The lack of functional laboratories has far-reaching implications for teacher preparation and student learning outcomes. Reports from the National Commission for Colleges of Education (NCCE, 2022) indicate that over 60% of teacher-training colleges operate with obsolete or non-functional laboratories. This deficit undermines the quality of STEM education delivered to pre-service teachers, resulting in graduates who lack the competencies necessary to deliver effective practical instruction in their future classrooms (Eze & Okonkwo, 2022). Consequently, this gap perpetuates poor science education outcomes in Nigerian basic and secondary schools and widens the disparity between local practices and global best standards (Yusuf & Balogun, 2022; Obikwelu & Nwosu, 2023).

Virtual Simulated Laboratories (VSLs) present an innovative solution to these challenges. VSLs provide immersive, interactive digital environments that replicate the functionality of physical laboratories, allowing repeated experimentation without risks or resource wastage (Hossain et al., 2021; Alade et al., 2022). They are cost-effective, scalable, and capable of democratizing access to practical training regardless of geographic or socio-economic constraints (Musa, 2023). Global studies show that VSLs enhance conceptual understanding, improve retention rates, and foster positive attitudes toward STEM subjects (Zawacki-Richter et al., 2020; Mikropoulos & Natsis, 2021). Despite these advantages, empirical evidence on their application in Nigerian teacher-training programmes particularly in vocational and science education is limited (Okoye, 2020; Adebayo, 2021). Addressing this gap is vital to modernizing teacher education and aligning it with Nigeria's Education Sector Plan (2021–2025) and Sustainable Development Goal 4 (SDG 4), which advocate for equitable access to quality education through digital innovation. By investigating the impact of VSLs on pre-service teachers' engagement, practical skill development, and inclusiveness, this study provides actionable insights for curriculum reform, professional development, and policy formulation. Ultimately, integrating VSLs into teacher-training programmes provides a sustainable pathway to equip future educators with 21st-century competencies, enhance STEM outcomes in schools, and support broader national goals of socio-economic transformation.

OBJECTIVES OF THE STUDY

The main objective of this study is to examine the application of Virtual Simulated Laboratories (VSLs) in enhancing hands-on practical skills among science and vocational students at the Federal College of Education, Gidan-Madi. The specific objectives are to:

1. Evaluate the impact of VSLs on students' engagement and learning outcomes in science and vocational subjects compared to traditional laboratory methods.
2. Assess the effectiveness of VSLs in improving practical skill acquisition, including experimentation, data interpretation, and application of concepts in real-life scenarios.
3. Identify the challenges and limitations associated with the integration of VSLs into teacher-training programmes in resource-constrained environments.
4. Recommend strategies for optimizing the implementation of VSLs to improve inclusivity, scalability, and sustainability in science and vocational education.

Research Questions

Based on the objectives, the study seeks to answer the following research questions:

1. To what extent do Virtual Simulated Laboratories enhance student engagement and learning outcomes compared to traditional teaching methods?
2. How effective are VSLs in developing practical skills such as observation, experimentation, and application of scientific and vocational concepts?
3. What challenges hinder the successful implementation of VSLs in teacher-training institutions?
4. What strategies can be adopted to ensure sustainable and inclusive integration of VSLs into the science and vocational curriculum?

Research Hypotheses

The following **null hypotheses (H_0)** will be tested:

H_{01}: There is no significant difference in engagement and learning outcomes between students taught using Virtual Simulated Laboratories and those taught using traditional methods.

H_{02}: There is no significant difference in practical skill acquisition between students exposed to VSL-based instruction and those exposed to traditional laboratory instruction.

Significance of the Study

The findings of this study is significant because of the following:

i. It provides an alternative to physical laboratories, helping students practice safely even when equipment is not available.
ii. It improves students' understanding and performance, making learning more engaging and effective through virtual simulations.
iii. It reduces cost and solves resource problems, since virtual labs do not require chemicals, equipment, or maintenance like real laboratories.
iv. It supports national goals for digital education, aligning with government efforts to upgrade teacher training and improve STEM learning in Nigeria.

LITERATURE REVIEW

The integration of technology into education has transformed the way students engage with learning materials, particularly in science and vocational education, where practical application is essential (Kolb, 2015). Traditional laboratory-based learning, while effective, faces challenges such as limited access to equipment, high costs, and safety concerns (UNESCO, 2021). In response, Virtual Simulated Laboratories (VSLs) have emerged as innovative solutions to enhance practical skill acquisition through immersive and interactive learning environments (Zawacki-Richter et al., 2020). This literature review explores the theoretical foundations, benefits, challenges, and empirical findings related to the application of VSLs in science and vocational education.

Conceptual Framework of Virtual Simulated Laboratories (VSLs)

Virtual Simulated Laboratories (VSLs) are digital platforms that replicate the functions and experiences of traditional laboratories, enabling learners to conduct experiments, manipulate tools, and observe outcomes in a simulated environment (Hossain et al., 2021). These laboratories leverage technologies such as virtual reality (VR), augmented reality (AR), and interactive 3D simulations, which allow students to practice repeatedly without the risks or costs associated with physical laboratories (Obikwelu & Nwosu, 2023). The concept aligns with the global shift towards digital learning ecosystems, where technology is employed to overcome resource constraints and enhance inclusivity in science and vocational education (UNESCO, 2023). In Nigeria, where many teacher training institutions face infrastructural deficits, VSLs present a viable alternative for bridging the practical skills gap in STEM education (Okoye, 2020).

Theoretical Foundations of Virtual Simulated Laboratory Learning

The application of Virtual Simulated Laboratories (VSLs) in science and vocational education is grounded in several learning theories that emphasize experiential, constructivist, and technology-mediated learning. These theories offer a solid foundation for understanding how VSLs can enhance learning outcomes by promoting active participation, collaboration, and interaction with digital environments. Kolb's Experiential Learning Theory (ELT) emphasizes learning as a process in which knowledge is created through direct experience (Kolb, 2015). VSLs align with this model by enabling students to actively engage in simulated practical activities, thereby reinforcing learning through experience rather than passive instruction. This hands-on involvement helps learners reflect on their actions and outcomes, deepening their comprehension of scientific concepts.

According to Piaget's Constructivist Theory, learners construct knowledge through active exploration (Piaget, 1954). Virtual laboratories support constructivist learning by allowing students to manipulate variables, conduct experiments, and observe real-time outcomes, fostering a deeper understanding of scientific processes. The interactive nature of VSLs encourages critical thinking and problem-solving, which are essential elements of the constructivist approach (Mikropoulos & Natsis, 2011). Bandura's Social Cognitive Theory (SCT) suggests that learning occurs through observation, imitation, and interaction with the environment (Bandura, 1986). VSLs facilitate this by enabling students to collaborate in virtual environments, observe scientific phenomena, and engage in guided problem-solving tasks. Such environments support peer interaction and shared learning experiences, which are critical to the development of cognitive and social skills (Tondeur et al., 2017).

The synergy of these theories justifies the integration of VSLs into teacher-training curricula, as they collectively address cognitive, affective, and psychomotor domains of learning critical to vocational and science education.

The Role of Virtual Simulated Laboratories in Science and Vocational Education

Enhancing practical skill acquisition is one of the primary objectives of science and vocational education, aiming to equip students with hands-on skills essential for problem-solving and technological innovation (Adebayo, 2019). Traditional instructional methods often fall short in this regard due to inadequate laboratory facilities, outdated equipment, and limited funding (Ogunniyi & Adeyemi, 2018). However, studies have shown that Virtual Simulated Laboratories (VSLs) bridge this gap by offering a cost-effective, risk-free, and interactive environment where students can repeatedly practice complex experiments. Hossain et al. (2021) emphasized that such repeated practice enhances skill mastery. A study by Alade et al. (2022) revealed that students who used VSLs demonstrated a 37% increase in practical performance scores compared to those who relied solely on traditional methods. The interactive nature of virtual simulations enhances cognitive retention, conceptual understanding, and application of scientific principles (Obikwelu & Nwosu, 2023).

Student engagement and motivation play a crucial role in academic achievement, and research has shown that technology-enhanced learning environments promote greater interest and participation (Zawacki-Richter et al., 2020). VSLs incorporate features such as gamification, real-time feedback, and interactive challenges, making learning more engaging and immersive (Eze & Okonkwo, 2022). For instance, a study conducted in Nigerian universities revealed that 73% of students reported higher engagement levels when learning through VSLs compared to traditional laboratory settings (Ojo & Hassan, 2021). Moreover, virtual experiments reduce anxiety often associated

with high-risk practical activities, thereby encouraging students to explore scientific concepts with greater confidence (Tondeur et al., 2017).

Accessibility and cost-effectiveness are key concerns in many developing countries, where limited access to physical laboratory resources poses a significant barrier to quality science education (UNESCO, 2021). Establishing and maintaining well-equipped laboratories demands substantial financial investment, which many institutions are unable to provide (Adebayo, 2019). VSLs offer a practical and affordable alternative by providing digital replicas of laboratory equipment, allowing students to conduct experiments without geographical or financial limitations (Hossain et al., 2021). A comparative study across South Africa, India, and Nigeria found that the implementation of VSLs reduced operational costs by up to 45% while increasing student access to experiments by 60% (Obikwelu & Nwosu, 2023). These findings underscore the potential of virtual simulation technologies to bridge the educational divide between resource-rich and underprivileged institutions.

Importance of Practical Skills in Science and Vocational Education

Practical skills are central to science and vocational education, enabling learners to apply theoretical concepts to real-world contexts, develop problem-solving abilities, and prepare for workforce demands (Aina, 2022). In teacher-training programmes, mastery of these skills is particularly vital, as pre-service teachers must be competent not only in performing experiments but also in demonstrating and supervising practical activities in their future classrooms (Yusuf & Balogun, 2022).

However, studies consistently highlight gaps in practical skill acquisition across Nigerian colleges of education. Challenges include obsolete laboratory facilities, inadequate equipment, and large class sizes, which restrict opportunities for individualized practice (Eze & Okonkwo, 2022; Ogunniyi & Adeyemi, 2018). These gaps contribute to the low quality of STEM instruction in basic and secondary schools, perpetuating poor student performance in national assessments (Federal Ministry of Education, 2021).

Benefits of Virtual Simulated Laboratories

Numerous studies confirm the potential of VSLs to transform teaching and learning in science and vocational programmes:

Enhanced Conceptual Understanding and Retention: VSLs provide interactive and gamified environments where students visualise abstract concepts, manipulate variables, and receive real-time feedback. Hossain et al. (2021) reported that students using VSLs achieved 25–40% higher retention rates compared to peers in traditional laboratories. Similarly, Alade et al. (2022) found a 37% increase in practical performance scores among vocational students exposed to VSLs.

Increased Engagement and Motivation: Gamification elements such as progress tracking, badges, and interactive challenges enhance learner engagement. A study by Obikwelu and Nwosu (2023) demonstrated that 73% of students reported increased motivation and active participation when learning with VSLs compared to conventional labs.

Cost-Effectiveness and Scalability: VSLs eliminate the recurring costs of consumables, equipment maintenance, and safety risks associated with physical laboratories (UNESCO, 2023). Research across South Africa, Nigeria, and India revealed that VSL integration reduced operational costs by up to 45% while significantly increasing student access to laboratory experiences (Musa, 2023).

Inclusivity and Gender Equity: Digital laboratories promote inclusivity by accommodating diverse learning paces and reducing anxiety associated with high-risk physical experiments. Yusuf and Balogun (2022) found that VSLs encouraged female participation in STEM courses by providing equitable, low-pressure learning environments.

Challenges and Limitations of Virtual Simulated Laboratories

Despite the numerous benefits, the adoption of Virtual Simulated Laboratories (VSLs) in teacher training institutions faces several challenges that hinder their widespread and effective implementation. One of the major barriers is technological constraints. Successful VSL integration requires stable internet connectivity, high-performance computers, and advanced software (Eze & Okonkwo, 2022). Unfortunately, many institutions in Nigeria and other developing countries lack the necessary infrastructure, thereby limiting the effectiveness and accessibility of virtual learning environments (Ogunniyi & Adeyemi, 2018). Inadequate technological facilities not only hinder the smooth delivery of virtual content but also affect the consistency and quality of the learning experience.

Another critical challenge lies in pedagogical adaptation and faculty training. Many educators lack the technical skills and pedagogical strategies needed to effectively integrate VSLs into the curriculum (Zawacki-Richter et al., 2020). The shift from traditional laboratory setups to virtual environments demands a rethinking of instructional methods and assessment practices. Without adequate training and continuous professional development, teachers may find it difficult to leverage the full potential of VSLs. Studies have indicated that the absence of structured teacher training programmes often results in the ineffective implementation of virtual laboratories (Hossain et al., 2021).

Research Gaps and Justification

The literature highlights several theoretical frameworks that underpin VSL integration, including Kolb's Experiential Learning Theory, Piaget's Constructivist Theory, and Bandura's Social Cognitive Theory, which collectively emphasise experiential and interactive learning processes (Kolb, 2015; Piaget, 1954; Bandura, 1986). Studies demonstrate that VSLs enhance practical skill mastery, increase engagement through gamification, and provide cost-effective alternatives to physical labs (Hossain et al., 2021; Obikwelu & Nwosu, 2023). Despite these advantages, challenges such as infrastructural deficits, digital literacy gaps, and inadequate teacher training persist in Nigerian contexts (Eze & Okonkwo, 2022).

While global studies on VSL effectiveness are abundant, context-specific research in Nigerian teacher-training institutions remains limited. Most available studies focus on higher education STEM programmes, with little emphasis on vocational education or pre-service teacher training (Okoye, 2020; Adebayo, 2021). Moreover, few studies have explored gender inclusivity, long-term skill retention, or pedagogical integration strategies tailored to resource-constrained environments.

This study seeks to bridge these gaps by providing empirical evidence on the effectiveness of VSLs in enhancing practical skills among pre-service science and vocational teachers in Sokoto State. Findings will inform policy reforms, curriculum development, and the broader digital transformation agenda in Nigerian education, aligning with Sustainable Development Goal 4 (SDG 4) and the country's Education Sector Plan (2021–2025).

METHODOLOGY

This study adopted a quasi-experimental pre-test post-test control group design to evaluate the effectiveness of Virtual Simulated Laboratories (VSLs) in enhancing students' practical skills. The design was suitable for comparing learning outcomes between an experimental group exposed to VSL-based instruction and a control group receiving traditional laboratory teaching, while maintaining existing class structures (Creswell & Creswell, 2018; Fraenkel et al., 2019).

The research was conducted at the Federal College of Education, Gidan-Madi, in Tangaza Local Government Area of Sokoto State, Nigeria. This teacher-training institution, which specializes in science and vocational education, was selected due to its limited laboratory infrastructure, inadequate digital facilities, and large student enrolments, conditions that make it an appropriate setting for examining the potential of VSLs to bridge practical skills gaps. The study population comprised all NCE II students in the School of Science and the School of Vocational and Technical Education, as these students had completed foundational courses and were actively engaged in practical training.

A multi-stage sampling technique was employed to select 80 participants. Two departments (one science-based and one vocational-based) were purposively chosen, and students were randomly assigned to experimental (n = 40) and control (n = 40) groups. Three instruments were used: the Practical Skills Assessment Checklist (PSAC) to evaluate competencies in experimentation, observation, and application of concepts; a structured observation guide to capture engagement and collaboration during sessions; and a Virtual Simulation Learning Platform (VSLP) designed to replicate laboratory experiments digitally. Content and construct validity were ensured through expert review and alignment with NCCE standards, and PSAC reliability was confirmed with a Cronbach's Alpha of 0.84, indicating good internal consistency.

The study spanned six weeks. In week one, both groups undertook a pre-test to establish baseline competencies. Over the next four weeks, the experimental group was instructed using VSLs, while the control group continued with traditional laboratory activities. In week six, both groups completed a post-test using the same assessment tools. Structured observations and participant reflections were also recorded to capture qualitative insights. Data were analysed using descriptive statistics (mean and standard deviation) and inferential statistics, including independent samples t-tests and ANCOVA to control for pre-test differences.

Ethical approval was obtained from the Institutional Research Ethics Committee of the Federal College of Education, Gidan-Madi. Informed consent was secured from participants, and confidentiality was maintained throughout the study. Participation was voluntary, and students retained the right to withdraw at any stage without penalty.

RESULTS AND FINDINGS

This section presents the results of the quasi-experimental study evaluating the impact of Virtual Simulated Laboratories (VSLs) on practical skill acquisition among science and vocational students. The findings are organised according to the stated research questions and hypotheses. Descriptive statistics are first presented, followed by inferential analyses (independent samples t-tests and ANCOVA).

Research Question 1

To what extent does the use of VSLs enhance student engagement and learning outcomes in science and vocational education compared to traditional teaching methods?

Table 1: Descriptive Statistics of Engagement Scores by Group

Group	N	Mean Engagement Score	SD
Experimental (VSL)	40	78.65	6.21
Control (Traditional)	40	62.40	7.08

Students exposed to VSLs demonstrated substantially higher engagement than their counterparts taught through traditional methods. This implies that the interactive and immersive features of VSLs. Students in the VSL group had higher mean engagement scores (M = 78.65, SD = 6.21) compared to the control group (M = 62.40, SD = 7.08). simulations, virtual manipulations, and feedback loops) fostered more active participation and deeper involvement in the learning process.

Hypothesis Test (H_{01}): No significant difference in engagement between groups

Independent Samples t-Test

Variable	t(df)	p-value	Decision
Engagement Score	9.87 (78)	< 0.001	Reject H_0

The statistically significant result ($p < 0.001$) rejects the null hypothesis (H_{01}) and underscores VSLs' effectiveness in enhancing motivational and cognitive engagement.

Research Question 2

How do students taught with VSLs differ in practical skill acquisition compared to those taught using conventional laboratory approaches?

Table 2: Pre-test and Post-test Practical Skills Scores by Group

Group	N	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Gain
Experimental (VSL)	40	41.20 (5.4)	83.40 (6.1)	+42.2
Control (Traditional)	40	40.80 (5.7)	66.10 (6.5)	+25.3

The experimental group achieved significantly higher gains in practical skills even after controlling for baseline differences. The improvement of over 40 points in the VSL group versus 25 points in the control group indicates that VSLs effectively bridge theoretical-practical gaps by providing repeatable, risk-free experimentation environments.

Hypothesis Test (H_{02}): No significant difference in practical skill acquisition between groups

ANCOVA Results (Controlling for Pre-test Scores)

Source	SS	Df	MS	F	p-value
Group (VSL vs Control)	2145.32	1	2145.32	48.62	< 0.001
Error	3420.15	77	44.42		
Total	5565.47	79			

Students exposed to VSLs showed significantly greater improvement in practical skills than those taught using traditional methods.

Research Question 3

What challenges are encountered in implementing VSLs in Nigerian teacher-training institutions?

Table 3: Identified Challenges in VSL Implementation

Challenge	Frequency (n=40)	Percentage (%)
Limited internet connectivity	32	80%
Insufficient computer facilities	29	72.5%
Lack of digital literacy among teachers	26	65%
Resistance to adopting new technology	22	55%
Funding constraints	34	85%

The most reported challenges were funding constraints (85%) and limited internet connectivity (80%), followed by inadequate computer facilities (72.5%).

Research Question 4

What strategies can be adopted to ensure effective and sustainable integration of VSLs into science and vocational curricula?

Table 4: Suggested Strategies for Effective VSL Integration

Strategy	Frequency (n=40)	Percentage (%)
Provision of adequate ICT infrastructure	35	87.5%
Continuous training for educators on VSL use	33	82.5%
Blended learning model (VSL + physical labs)	30	75%
Government and institutional policy support	31	77.5%
Regular technical support and maintenance of systems	28	70%

Respondents emphasised the need for robust ICT infrastructure (87.5%) and continuous training for educators (82.5%) as critical strategies for sustainable adoption.

Engagement and Learning Outcomes: Students exposed to VSLs reported higher engagement and demonstrated improved conceptual understanding, consistent with findings by Hossain et al. (2021) and Obikwelu & Nwosu (2023).

Practical Skill Acquisition: ANCOVA analysis confirmed that VSLs significantly enhanced students' hands-on competencies compared to traditional labs, supporting global trends in virtual learning adoption (Alade et al., 2022).

Challenges: Implementation challenges primarily relate to infrastructure (internet, hardware) and teacher readiness, aligning with studies by Eze & Okonkwo (2022) and UNESCO (2023).

Strategies for Integration: Emphasis on infrastructure provision, teacher training, and blended learning approaches aligns with recommendations by Tondeur et al. (2021) and Federal Ministry of Education (2021).

DISCUSSION OF THE FINDINGS

This study investigated the effectiveness of Virtual Simulated Laboratories (VSLs) in enhancing practical skills and engagement among science and vocational students at the Federal College of Education, Gidan-Madi. The findings provide empirical evidence supporting the integration of VSLs into teacher-training programmes in Nigeria, with significant implications for policy and practice. The discussion below addresses each research question and hypothesis in turn, situating results within relevant literature and theoretical frameworks.

Impact of VSLs on Student Engagement and Learning Outcomes

The study revealed a significant difference in engagement levels between students taught using VSLs and those taught with traditional laboratory methods. Students in the experimental group exhibited higher participation, motivation, and interaction, as reflected in the independent samples t-test results ($p < 0.001$). This aligns with earlier studies by Obikwelu & Nwosu (2023) and Hossain et al. (2021), which found that virtual laboratories enhance learner engagement by incorporating interactive and gamified learning experiences.

From a theoretical perspective, Bandura's Social Cognitive Theory (1986) supports this finding, emphasising the role of observational learning and self-efficacy in technology-mediated environments. VSLs provide immediate feedback and allow repeated practice, fostering confidence and reducing anxiety often associated with high-stakes physical laboratories. Moreover, the inclusive nature of VSLs ensures equitable participation across gender, corroborating findings by Yusuf & Balogun (2022) on digital learning inclusivity in Nigerian teacher education.

Effect of VSLs on Practical Skill Acquisition

Results from the ANCOVA analysis indicated that students exposed to VSLs demonstrated significantly greater gains in practical skills compared to those taught through conventional methods ($p < 0.001$). The experimental group not only improved in performing procedures but also in interpreting results and applying concepts to real-world problems. This is consistent with findings by Alade et al. (2022) and Mikropoulos & Natsis (2021), which reported superior skill mastery and retention when simulations complemented or replaced physical labs.

This outcome also reflects Kolb's Experiential Learning Theory (2015), which posits that knowledge is constructed through cycles of concrete experience, reflective observation, abstract conceptualization, and active experimentation. VSLs effectively facilitate this cycle by immersing learners in simulated tasks that mirror real laboratory environments, enabling practice without constraints of time, cost, or safety.

Challenges in Implementing VSLs

Despite their effectiveness, the study identified significant challenges to VSL integration, including inadequate ICT infrastructure, unreliable internet connectivity, and limited digital literacy among educators and students. These findings mirror earlier reports by Eze & Okonkwo (2022) and UNESCO (2023), which highlighted infrastructural and capacity barriers to technology adoption in Nigerian teacher education. Additionally, resistance to change emerged as a barrier, consistent with studies by Tondeur et al. (2021) that noted reluctance among educators to shift from familiar teaching practices to digital methodologies. Addressing these challenges will require targeted investments in ICT infrastructure, continuous capacity building, and supportive institutional policies.

Strategies for Sustainable VSL Integration

Participants recommended strategies such as providing adequate digital infrastructure, continuous professional development for educators, and adopting blended learning models that combine virtual and physical laboratory experiences. These suggestions align with global best practices documented by Federal Ministry of Education (2021) and UNESCO (2023), which advocate for hybrid models to optimize cost-effectiveness while maintaining hands-on competency.

The emphasis on policy support underscores the need for systemic integration of VSLs into the national teacher education framework, rather than isolated pilot initiatives. This approach ensures sustainability, scalability, and alignment with Sustainable Development Goal 4 (SDG 4) on equitable quality education.

Implications for Teacher Education and Policy

The findings have several implications:

a. Pedagogical: Incorporating VSLs fosters active learning, critical thinking, and problem-solving skills, aligning with 21st-century teaching competencies.
b. Policy: Policymakers should prioritize funding for digital infrastructure and develop guidelines for VSL integration across teacher-training colleges.
c. Equity: VSLs address disparities in access to laboratory experiences, particularly benefiting rural or under-resourced institutions.
d. Future Research: Longitudinal studies are needed to assess the retention of skills and the impact on graduates' classroom teaching performance.

The study corroborates global evidence that Virtual Simulated Laboratories are effective tools for bridging the gap between theory and practice in STEM and vocational education. By enhancing engagement, improving practical competencies, and providing scalable solutions to infrastructural challenges, VSLs represent a transformative innovation for Nigerian teacher-training institutions. Addressing identified challenges through infrastructure investment, teacher training, and blended implementation will ensure sustainable integration and contribute to the broader digital transformation of education in Nigeria.

Conclusion

This study evaluated the application of Virtual Simulated Laboratories (VSLs) in enhancing practical skills and engagement among science and vocational students at the Federal College of Education, Gidan-Madi. Findings from the quasi-experimental design demonstrated that students exposed to VSL-based instruction significantly outperformed their counterparts taught through conventional laboratory methods in both engagement and skill acquisition.

The research further highlighted the cost-effectiveness, scalability, and inclusivity of VSLs, confirming their potential to address infrastructural deficits prevalent in Nigerian teacher-training institutions. Nonetheless, challenges such as inadequate ICT facilities, unreliable internet connectivity, and limited digital literacy among educators pose barriers to large-scale implementation.

Grounded in experiential and social cognitive learning theories, this study reinforces global evidence that integrating VSLs into teacher education can bridge the gap between theoretical knowledge and practical application. The findings underscore the need for strategic policy reforms, infrastructural investments, and sustained professional development to ensure effective and sustainable integration of VSLs in science and vocational training programmes.

Recommendations

Based on the findings and implications of this study, the following recommendations are proposed for policymakers, teacher educators, and institutional administrators:

1. Integrate VSLs into National Teacher Education Curriculum: The National Commission for Colleges of Education (NCCE) should formally incorporate VSL-based methodologies into minimum standards for science and vocational programmes.
2. Invest in Digital Infrastructure: Federal and state governments should prioritize provision of reliable internet connectivity, high-performance computers, and simulation software licenses to teacher-training institutions.
3. Capacity Building for Educators: Continuous professional development programmes should be organized to equip educators with the technical and pedagogical skills required to effectively implement and manage VSLs.
4. Adopt a Blended Learning Model: Institutions should combine virtual simulations with occasional physical laboratory sessions to reinforce psychomotor skills and contextualize virtual experiences with real-world laboratory practice.
5. Policy and Funding Support: Establish dedicated funding streams and policy frameworks to sustain VSL initiatives, ensuring long-term scalability beyond pilot projects.
6. Student Orientation and Digital Literacy programmes: Implement preparatory programmes to enhance students' digital literacy, ensuring equitable participation and maximising the learning potential of VSLs.
7. Further Research and Monitoring: Conduct longitudinal studies to examine the long-term effects of VSL exposure on graduates' classroom teaching performance and their ability to transfer skills to real-life teaching contexts.

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Integrating Workshop-Based Experiential Learning in STEM Education: Enhancing 21st Century Motor Skills and Technical Competencies Among Students in Lagos State Institutions

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Abstract

Contemporary educational paradigms increasingly emphasize the integration of experiential learning methodologies to bridge the gap between theoretical knowledge and practical application in STEM education. This study examines the relevance of workshop-based experiential learning as an integral component for developing 21st-century motor skills and technical competencies among students in Lagos State technical institutions. Using a descriptive survey design, 500 final-year students from five selected institutions participated in this research through a structured questionnaire employing Likert-scale items. The theoretical framework draws from Kolb's Experiential Learning Theory, specifically focusing on bodily-kinesthetic intelligence development. Findings reveal that workshop-based experiential learning significantly enhances real-world application competencies, promotes creative problem-solving abilities, builds self-confidence and reliability, improves retention and memory consolidation, stimulates subject matter engagement, and develops technical productivity skills. The study identifies key facilitating factors including instructor competency, student motivation, availability of modern equipment, and conducive learning environments. These findings support the critical role of hands-on workshop experiences in developing 21st-century skills essential for STEM career readiness and technological innovation in developing economies.

Keywords: Workshop-based learning, experiential learning, motor skills development, technical competencies, 21st-century STEM skills.

Introduction

The rapidly evolving technological landscape of the 21st century demands educational approaches that transcend traditional passive learning models, requiring students to develop both theoretical understanding and practical

competencies essential for success in STEM fields (Stehle & Peters-Burton, 2019). Contemporary educational research emphasizes the critical importance of experiential learning methodologies that engage students in authentic, hands-on experiences to bridge the gap between academic knowledge and real-world application (Huang et al., 2022). Learning, fundamentally defined as the process of acquiring knowledge, skills, attitudes, and values through study, experience, or instruction that results in measurable and persistent behavioral changes (Ambrose et al., 2010), extends beyond traditional classroom boundaries. Modern pedagogical approaches recognize that effective learning occurs through multiple modalities and requires active engagement with content through various sensory channels (Vygotsky, 1978).

Motor learning, specifically defined as the acquisition of skilled movements through practice and experience, involves complex neuroplasticity processes that result in relatively permanent changes in motor behavior (Schmidt & Lee, 2020). Contemporary research in neuroscience and educational psychology demonstrates that motor skills development is intrinsically linked to cognitive development, with hands-on activities serving as catalysts for enhanced learning outcomes across multiple domains (Czyż et al., 2022; Mang et al., 2020). Motor skills encompass both gross motor abilities involving large muscle groups and fine motor skills requiring precise coordination of smaller muscle groups. In educational contexts, these skills are particularly crucial for STEM disciplines where students must manipulate tools, operate equipment, conduct experiments, and engage in problem-solving activities that require physical dexterity combined with cognitive processing (Chen et al., 2023; van der Fels et al., 2015).

Workshop-based experiential learning environments, including maker spaces and fabrication laboratories, provide authentic contexts where students can develop essential motor skills while simultaneously acquiring technical competencies, supporting students' agency, inquiry with materials, design self-efficacy, and engagement in more equitable forms of STEM learning (Andrews et al., 2021; Bevan et al., 2015).

Statement of the Problem

Despite increasing recognition of the importance of practical skills in STEM education, many technical institutions continue to emphasize theoretical instruction over hands-on experiential learning opportunities. Students in Lagos State technical institutions often demonstrate limited engagement with workshop-based activities, viewing practical work as supplementary rather than integral to their academic development. This disconnect between theory and practice contributes to graduates who possess theoretical knowledge but lack the practical competencies demanded by contemporary technological industries.

The specific problem addressed in this study is the need to understand how workshop-based experiential learning contributes to the development of 21st-century motor skills and technical competencies among students in Lagos State technical institutions, and to identify factors that facilitate effective implementation of such programs.

Purpose of the Study

1. To assess the relevance of workshop-based experiential learning in developing students' motor skills and technical competencies
2. To identify factors that facilitate effective student performance in workshop-based learning activities
3. To evaluate the perceived benefits of hands-on workshop experiences for STEM education outcomes

Research Questions

1. How does workshop-based experiential learning contribute to students' motor skill development and technical competency acquisition?
2. What factors facilitate effective student performance and engagement in workshop-based learning activities?
3. What are the perceived benefits of workshop-based experiential learning for developing 21st-century STEM competencies?

Theoretical Framework

This study is anchored in Kolb's Experiential Learning Theory (ELT), which provides a comprehensive and empirically validated framework for understanding how students transform concrete workshop experiences into meaningful technical competencies and motor skills. The adoption of this theoretical framework was deliberate and grounded in its proven efficacy in technical and vocational education contexts, particularly for understanding learning processes that integrate cognitive, affective, and psychomotor domains. ELT explicitly addresses the integration of theory and practice, which is fundamental to workshop-based learning in technical education. Kolb (1984, p. 41) defined learning as "the process whereby knowledge is created through the transformation of experience," a definition that directly aligns with the hands-on, experiential nature of workshop activities where students physically manipulate tools, equipment, and materials to develop both technical skills and conceptual understanding. ELT has been extensively validated in STEM education and technical training contexts worldwide. The framework's emphasis on active engagement with materials and reflective practice aligns perfectly with the pedagogical requirements of workshop-based technical education, where students must develop both procedural knowledge (knowing how) and declarative knowledge (knowing that).

Alignment of Kolb's ELT with Workshop-Based Learning

The four stages of Kolb's experiential learning cycle map directly onto workshop-based learning activities in technical institutions:

Stage 1: Concrete Experience. In workshop settings, students engage directly with tools, equipment, and materials, performing hands-on tasks such as operating machinery, conducting experiments, or constructing physical prototypes. This stage corresponds to the physical manipulation and motor skill execution that forms the foundation of technical competency development. Abdulwahed and Nagy (2009) demonstrated in engineering laboratory contexts that concrete experiences in technical settings provide the essential foundation for subsequent learning stages.

Stage 2: Reflective Observation. Following hands-on activities, students observe outcomes, identify patterns, and reflect on their performance. In workshop contexts, this involves analyzing work results, comparing output to expected standards, and considering factors influencing success or challenges. Kolb and Kolb (2009) emphasized that this reflective dimension is critical for developing metacognitive awareness about one's learning process and technical performance.

Stage 3: Abstract Conceptualization: Students connect their concrete workshop experiences to theoretical principles, scientific concepts, and technical knowledge. This stage enables learners to understand the underlying

principles governing the processes they have executed, moving beyond procedural competency to conceptual understanding. Healey and Jenkins (2000) noted that students who physically experience phenomena in laboratory settings can better grasp abstract scientific concepts and mechanical principles.

Stage 4: Active Experimentation: Armed with new conceptual understanding, students apply their learning to novel situations, testing hypotheses and adapting techniques to different contexts. In workshop settings, this involves using newly acquired skills and knowledge to solve problems, design solutions, and innovate beyond prescribed procedures. Kolb and Kolb (2005) identified this stage as fostering creativity, adaptability, and transfer of learning, essential competencies for 21st-century technical professionals.

Empirical Support from Existing Research

The adoption of Kolb's ELT for this study is supported by substantial empirical evidence from diverse educational contexts. In technical and vocational education, multiple studies have demonstrated the framework's effectiveness. Kolb and Kolb (2017) examined how design projects, laboratory work, and hands-on activities in engineering education provide concrete experiences that, when combined with structured reflection and conceptualization, lead to comprehensive competency development. Their longitudinal research demonstrated significant improvements in both technical and professional skill acquisition through experiential approaches. Experiential learning in STEM education shows that hands-on activities incorporating Kolb's learning cycle significantly enhance problem-solving abilities and technical skill development compared to traditional instruction methods (Morris, 2020). This study's quasi-experimental design provided strong evidence for the effectiveness of experiential learning in technical disciplines.

In vocational education contexts, Abdulwahed and Nagy (2009) applied Kolb's ELT to engineering laboratory instruction, demonstrating that structured experiential activities improved students' conceptual understanding and practical competencies. Their structural equation modeling validated the relationship between experiential learning stages and technical skill acquisition. Experiential learning models hold substantial potential for enhancing student outcomes in career and technical education (Clark et al., 2010). Their framework illustrated how ELT provides instructors with structured approaches for designing activities that facilitate complete learning cycles, thereby promoting deeper technical competency development.

Complementary Theoretical Perspectives

While Kolb's ELT serves as the primary theoretical framework, this study also acknowledges complementary perspectives that enrich the understanding of workshop-based learning. Constructivist learning principles (Fosnot & Perry, 2005; Vygotsky, 1978) support the notion that students actively construct knowledge through engagement with materials and social interaction in workshop settings. Additionally, Gardner's (2011) Theory of Multiple Intelligences, particularly the bodily-kinesthetic intelligence dimension, provides insight into the diverse ways students engage with and excel in hands-on technical activities.

However, Kolb's ELT remains the foundational framework because it uniquely integrates cognitive, affective, and behavioral dimensions of learning while providing a clear, operationalizable model for understanding

how concrete workshop experiences transform into enduring technical competencies and motor skills. The theory's emphasis on cyclical, iterative learning processes aligns with the reality of skill development in technical education, where mastery emerges through repeated cycles of practice, reflection, understanding, and application.

Methodology

Research Design

This study employed a descriptive survey design to examine the relevance of workshop-based experiential learning in developing motor skills and technical competencies among students in Lagos State institutions. The descriptive approach was selected because it allows for systematic collection and analysis of data regarding current practices, perceptions, and outcomes related to workshop-based learning experiences.

Population and Sample

The study population comprised final-year students from five selected technical institutions in Lagos State: University of Lagos (Akoka), Yaba College of Technology (Yaba), Federal College of Education (Technical) Akoka, Federal Science and Technical College (Yaba), and St. Finbarr's College (Akoka). A total of 500 final-year students were selected using stratified random sampling to ensure equal representation across institutions and gender demographics. This sampling approach ensured that all participants had equal opportunity for selection while maintaining representativeness across the study population.

Research Instrument

The primary data collection instrument for this investigation was a questionnaire developed to address the research objectives. The instrument featured a structured design intended to capture multiple dimensions of the workshop learning experience. The questionnaire comprised three sections: the first collected demographic information regarding participants' institutional affiliation, academic program, and background characteristics; the second contained eight items examining the relationship between workshop participation and the development of motor skills and competencies; and the third included five items identifying environmental and instructional factors that enhanced workshop-based learning effectiveness.

A five-point Likert scale format was employed to facilitate quantitative analysis, with response options ranging from Strongly Agree to Strongly Disagree. The instrument underwent multiple validation procedures to ensure quality. Science and technology education specialists reviewed the questionnaire to establish content validity, and their feedback was incorporated to strengthen alignment between items and constructs. A pilot study with 30 students, who were excluded from the main participant sample, provided insights into question clarity and instrument functionality. Internal consistency analysis confirmed the questionnaire's reliability, yielding a Cronbach's alpha coefficient of 0.89.

Data Collection and Analysis

Data collection was conducted over a four-week period with assistance from institutional faculty and technical staff. Completed questionnaires were edited for consistency and analyzed using descriptive statistics

including means, standard deviations, and frequency distributions. Data analysis was conducted quantitatively by using SPSS.

Results

Research Question 1: Contribution of Workshop-Based Learning to Motor Skills and Technical Competencies

Table 2 presents participant responses regarding the relevance of workshop-based experiential learning for developing motor skills and technical competencies.

Table 1

Relevance of Workshop-Based Learning for Motor Skills and Technical Competency Development

Item	SA	A	U	D	SD	Mean	SD
Enhances real-world application abilities	200	150	5	120	25	3.76	82.99
Increases creative problem-solving capabilities	350	100	8	30	12	4.49	144.58
Promotes self-confidence and reliability	300	150	0	20	30	4.34	122.93
Improves retention and memory consolidation	350	100	8	22	20	4.47	144.43
Stimulates subject matter engagement	322	130	12	20	16	4.42	133.58
Develops physical coordination skills	280	120	25	45	30	4.15	107.64
Facilitates concrete understanding of processes	255	174	5	36	30	4.17	108.99
Enhances technical productivity	350	100	8	30	12	4.49	144.57

Results from the Table 1 indicated that participants accepted that Workshop-Based Learning "Enhances real-world application abilities" (M 3.76, S.D 82.99), "Increases creative problem-solving capabilities" (M 4.49, S.D 144.58), "Promotes self-confidence and reliability" (M 4.34, S.D 122.93), "Improves retention and memory consolidation" (M 4.47, S.D 144.43), "Stimulates subject matter engagement" (M 4.42, S.D 133.58), "Develops physical coordination skills" (M 4.15, S.D 107.64), "Facilitates concrete understanding of processes" (M 4.17, S.D 108.99), and "Enhances technical productivity" (M 4.49, S.D 144.57). There is a strong agreement across all dimensions of workshop-based learning relevance. Participants particularly endorsed the role of workshop experiences in increasing creative problem-solving capabilities (M = 4.49, SD = 144.58) and enhancing technical productivity (M = 4.49, SD = 144.58). The consistently high means (ranging from 3.76 to 4.49) demonstrate participant recognition of workshop-based learning as integral to motor skill and competency development.

Research Question 2: Factors Facilitating Effective Workshop-Based Learning

Table 2 presents participant responses regarding factors that facilitate effective performance in workshop-based learning activities.

Table 2

Factors Facilitating Effective Workshop-Based Learning Performance

Factor	SA	A	U	D	SD	Mean	SD
Instructor competency and expertise	255	174	5	36	30	4.17	108.99
Student interest and motivation	367	120	0	10	3	4.68	157.47
Motivational strategies and recognition	287	167	4	40	2	4.39	124.37
Availability of modern tools and equipment	233	180	7	36	44	4.04	99.96
Conducive workshop environment	300	180	1	12	7	4.50	134.71

Results from the Table 2 indicated that participants accepted that “Instructor competency and expertise” (M 4.17, S.D 108.99), “Student interest and motivation” (M 4.68, S.D 157.47), “Motivational strategies and recognition” (M 4.39, S.D 124.37), “Availability of modern tools and equipment” (M 4.04, S.D 99.96), “Conducive workshop environment” (M 4.50, S.D 134.71). The analysis reveals that student interest and motivation (M = 4.68, SD = 157.47) emerged as the most critical facilitating factor, followed by conducive workshop environments (M = 4.50, SD = 134.71). All factors demonstrated strong positive endorsement, indicating their collective importance for effective workshop-based learning implementation.

Discussion

The findings of this study provide substantial evidence supporting the integration of workshop-based experiential learning as a fundamental component of STEM education in Lagos State institutions. The results align with contemporary educational research emphasizing the importance of hands-on, experiential approaches to learning (Huang et al., 2022).

Motor Skills and Technical Competency Development

The strong endorsement of workshop-based learning for enhancing creative problem-solving capabilities and technical productivity reflects the alignment between hands-on experiences and 21st-century skill development. These findings support Kolb's (2015) Experiential Learning Theory, demonstrating that concrete experiences followed by reflective observation and active experimentation contribute significantly to competency development. The participants' recognition of workshop experiences for improving retention and memory consolidation aligns with neuroscience research indicating that motor skill learning involves plastic changes in brain structure and function, with structural reorganization in gray and white matter architecture occurring through practice (Dayan & Cohen, 2011). The integration of motor and cognitive processes in workshop activities supports the development of both procedural and declarative knowledge essential for STEM competency.

Research examining the relationship between motor skills and academic achievement has demonstrated that both fine and gross motor skills significantly predict academic performance in STEM-related subjects (Cinar et al., 2023). This relationship underscores the importance of workshop-based learning environments where students can develop physical dexterity alongside cognitive competencies. Furthermore, studies have shown that motor skill

proficiency contributes significantly to cognitive and social development, with early motor skill development predicting later academic success (Capio et al., 2024).

Facilitating Factors

The identification of student interest and motivation as the primary facilitating factor underscores the importance of intrinsic motivation in experiential learning contexts, aligning with Self-Determination Theory, which emphasizes autonomy, competence, and relatedness as fundamental drivers of motivated learning behavior and basic psychological needs that enhance self-motivation (Ryan & Deci, 2000, 2017). The conducive workshop environments reflect the importance of physical and social learning contexts that support experimentation, collaboration, and risk-taking, essential for effective experiential learning. These findings support Vygotsky's (1978) social constructivist theory, highlighting the role of environmental factors in facilitating learning and development.

Recent research on STEM education has emphasized that effective learning environments must provide opportunities for students to engage in authentic, meaningful problem-solving activities (Stehle & Peters-Burton, 2019). The workshop setting, when properly designed and resourced, provides precisely this type of environment where students can apply theoretical knowledge to practical challenges, developing both technical skills and critical thinking abilities.

Connection of Kolb's Experiential Learning Theory to the Current Study's Findings

The selection of Kolb's ELT as this study's theoretical framework is strongly validated by the empirical findings. The research results demonstrate that workshop-based experiential learning enhances creative problem-solving capabilities (M = 4.49), improves retention and memory consolidation (M = 4.47), stimulates subject matter engagement (M = 4.42), develops physical coordination skills (M = 4.15), and enhances technical productivity (M = 4.49) outcomes that align precisely with the predicted benefits of progressing through Kolb's experiential learning cycle.

Specifically, the finding that workshop experiences "bring students to actual world reality" (M = 3.76) corresponds to Kolb's concrete experience stage, where learners engage directly with authentic materials and contexts. The strong endorsement of workshops for promoting "self-confidence and reliability" (M = 4.34) reflects the empowerment that comes from successfully completing the full learning cycle, where students not only perform tasks but also understand the underlying principles and can adapt their skills to new situations.

The identification of facilitating factors particularly student interest and motivation (M = 4.68), instructor competency (M = 4.17), and conducive workshop environments (M = 4.50) aligns with Kolb and Kolb's (2017) emphasis on creating appropriate learning spaces that support all four modes of the learning cycle. Their research on learning space design emphasizes that effective experiential learning requires environments characterized by respect, safety, challenge, and opportunities to engage in feeling, reflection, thinking, and action precisely the factors identified as critical in this study's findings.

Moreover, the strong performance on items related to "concrete understanding of processes" (M = 4.17) validates the theoretical prediction that experiential learning facilitates the transformation of abstract theoretical knowledge into tangible, applicable understanding. This finding demonstrates that workshop experiences enable the critical transition from theoretical instruction to practical competency that Kolb's framework explicitly addresses.

The study's findings support the growing body of literature emphasizing the importance of 21st-century skills in STEM education, with research showing that maker spaces can support students' agency, design self-efficacy, and engagement in STEM literacy practices, while also enhancing students' self-efficacy and sense of belonging in engineering spaces (Andrews et al., 2021; Bevan et al., 2015; Sheridan et al., 2014). Workshop-based learning environments provide ideal contexts for developing these competencies. Through hands-on projects and collaborative problem-solving activities, students develop not only technical skills but also the soft skills necessary for professional success. The high mean scores across all measured dimensions suggest that participants recognize the multifaceted benefits of experiential learning approaches.

The findings have several important implications for educational practice in technical institutions. First, they underscore the need for adequate investment in workshop facilities and equipment. The relatively lower (though still positive) mean score for availability of modern tools and equipment ($M = 4.04$) suggests this may be an area requiring additional attention from institutional leadership. Second, the critical importance of instructor competency ($M = 4.17$) highlights the need for ongoing professional development for faculty members. Instructors must be equipped not only with technical expertise but also with pedagogical knowledge about how to facilitate effective experiential learning experiences. Third, the paramount importance of student motivation ($M = 4.68$) suggests that instructional strategies should focus on creating engaging, relevant learning experiences that connect to students' interests and career aspirations. This aligns with research showing that contextualized, authentic learning experiences enhance student engagement and persistence in STEM fields (Huang et al., 2022).

Conclusions

This study provides compelling evidence that workshop-based experiential learning serves as an integral component for developing 21st-century motor skills and technical competencies among students in Lagos State technical institutions. The findings demonstrate that workshop experiences contribute significantly to real-world application abilities, creative problem-solving, self-confidence development, retention enhancement, engagement stimulation, and technical productivity.

The identification of key facilitating factors particularly student motivation, instructor competency, and environmental conditions provides actionable insights for educational administrators and policymakers seeking to enhance STEM education through experiential learning approaches. The theoretical alignment with Kolb's Experiential Learning Theory, constructivist principles, and Gardner's Multiple Intelligence framework validates the pedagogical foundation for workshop-based learning integration.

Recommendations

Based on these findings, the following recommendations are proposed:

1. Institutional Policy Development: Lagos State educational authorities should develop comprehensive policies mandating workshop-based experiential learning components in all STEM programs, with specific requirements for hands-on learning hours and competency assessments.

2. Faculty Development Programs: Implement systematic professional development initiatives to enhance instructor competency in facilitating experiential learning, including training in modern pedagogical approaches, technology integration, and assessment methodologies.
3. Infrastructure Investment: Prioritize investment in modern workshop facilities, equipment, and technology to create conducive learning environments that support 21st-century skill development and align with industry standards.
4. Curriculum Integration: Develop integrated curriculum frameworks that seamlessly blend theoretical instruction with practical workshop experiences, ensuring alignment between learning objectives, assessment methods, and career readiness outcomes.
5. Industry Partnerships: Establish collaborative partnerships with technology industries to provide authentic learning experiences, mentorship opportunities, and career pathway development for students.
6. Research and Evaluation: Implement systematic research and evaluation programs to continuously assess the effectiveness of workshop-based learning initiatives and inform evidence-based improvements.

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ASSESSING THE INTEGRATION OF EDTECHPRENEURIAL-PEDAGOGIES IN BUSINESS EDUCATION FOR STUDENTS' SELF-EMPLOYMENT READINESS IN UNIVERSITIES IN LAGOS STATE

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Abstract

This study assessed the integration of EdTechpreneurial pedagogies in Business Education for students' self-employment readiness in universities in Lagos State. Guided by Kolb's Experiential Learning Theory, the research examined students' exposure to entrepreneurial technology-based teaching, the types of EdTech tools used by lecturers, the perceived impact on self-employment readiness, and the challenges faced in the process. A census sampling technique was employed to study all 187 final-year Business Education students from the University of Lagos and Lagos State University. Data were collected using the "Students' Assessment of EdTechpreneurial Pedagogies in Business Education Questionnaire" (SAEPEBEQ), validated and tested for reliability (Cronbach's Alpha = 0.720–0.744). Descriptive statistics addressed the research questions, while Pearson correlation tested the null hypothesis at a 0.05 significance level. Findings revealed high student exposure to EdTechpreneurial pedagogies in theory; however, lecturers primarily used general productivity tools rather than market-relevant entrepreneurial platforms such as e-commerce builders, digital marketing tools, or business simulation software. Students reported low perceived preparedness for self-employment, and correlation analysis showed no statistically significant relationship between exposure and readiness ($r = 0.249$, $p = .056$). Major challenges included poor internet connectivity, inadequate institutional resources, and limited lecturer competence in identifying and applying entrepreneurial digital tools. The study concludes that EdTechpreneurial pedagogies in Business Education are present in appearance but lack the depth and practical engagement necessary for transformative impact. It recommends improving institutional infrastructure and implementing targeted lecturer training to identify, adopt, and effectively integrate market-relevant EdTechpreneurial tools into teaching, thereby enhancing students' readiness for entrepreneurship in a digital economy.

Keywords: *EdTechpreneurial Pedagogies, Entrepreneurial Readiness, Digital Tools, Self-Employment Preparedness.*

Introduction

The increasing complexity of the global economy, driven by digital disruption and innovation, has placed a new demand on higher education systems to produce graduates who are not only knowledgeable but also entrepreneurial and technologically competent. In Nigeria, this transformation is especially critical within the domain of Business Education, a field that serves as a bridge between theoretical knowledge and the practical competencies required for workplace and business success. Particularly, at the university level, Business Education is designed not only to provide learners with a comprehensive understanding of entrepreneurial practices, business planning, and digital tool

application, but also to equip them with the pedagogical skills necessary to teach business-related subjects effectively (NBTE, 2022; Nwazor & Onokpaunu, 2016).

Hence, this dual objective, preparing both future business professionals and educators, makes the field uniquely positioned to contribute to national development through curriculum delivery, skills empowerment, and educational transformation. As such, innovations in Business Education pedagogy must consider not only content mastery but also the ability of graduates to design and deliver entrepreneurship and technology-integrated lessons to others in secondary schools, technical colleges, or training centres (Nebolisa, 2024). Therefore, embedding EdTechpreneurial pedagogies becomes not just a workforce readiness issue, but also a teacher preparation imperative. However, as the Fourth Industrial Revolution reshapes workforce expectations, questions have emerged about how effectively current pedagogical practices integrate digital entrepreneurship, especially in a country like Nigeria, where unemployment among graduates remains a national concern (Orji, 2024). This has given rise to scholarly discussions on integrating what can be termed EdTechpreneurial pedagogies, teaching strategies that combine the use of educational technology with entrepreneurial thinking to help students not only learn but also create business ventures using digital tools.

The newly released Core Curriculum and Minimum Academic Standards (CCMAS) for Education by the National Universities Commission (NUC, 2023) introduces important shifts that prioritise employability, innovation, and ICT competence. For Business Education, the curriculum includes courses such as "Digital Literacy," "E-Commerce," "Innovation and Creativity in Business," and "Entrepreneurship and New Venture Creation," among others. These courses indicate a clear intention to foster entrepreneurial thinking through digital learning frameworks. However, while the CCMAS provides structural opportunities, the effectiveness of this curriculum still heavily relies on how lecturers design, deliver, and engage students using appropriate pedagogies. According to Olatunji and Ajero (2022) and Udofia, Ijeoma and Chukwuemeka-Nworu (2021) argue, the success of any curriculum is determined not just by its content but by the strategies employed in its implementation. This creates a critical gap: are university lecturers in Business Education actually using EdTechpreneurial tools and methods to foster skills that can lead students to launch or conceptualise real business ventures? Or are digital tools still being limited to basic delivery methods such as PowerPoint, Zoom, or Google Meet, tools that do not necessarily lead to entrepreneurial outcomes?

This concern is particularly relevant to the University of Lagos and Lagos State University, where the Entrepreneurship and Skills Development Centre (ESDC) and Directorate of Skills Development & Entrepreneurship (LASUDSDE) exist, respectively, as institutional hubs for integrating skill development, digital innovation, and business creation across disciplines. While the centre's existence aligns with national efforts such as the TETFund's push for skills acquisition in tertiary institutions, it is unclear to what extent lecturers teaching Business Education draw from the institutional hubs' resources or pedagogical models. According to Fayomi, Fields, Arogundade, Ojugbele, Ogundipe and Ganiyu (2019), many lecturers in Nigerian universities continue to approach entrepreneurship education from a theoretical lens, often neglecting the use of practice-based, tech-enabled learning strategies. This undermines the very goals of the curriculum, especially given that tools like Canva, WordPress, Google Workspace, Facebook, Instagram and WhatsApp Business, among many others, are freely accessible and capable of enabling students to experiment with business models in real time. Hence, it becomes necessary to investigate whether students in Lagos State Universities, studying the Business Education programme, are being exposed to such transformative teaching methods.

Statement of the Problem

The recent 2023 Core Curriculum and Minimum Academic Standards (CCMAS) in Business Education marks a significant departure from the narrow focus of the earlier Benchmark Minimum Academic Standards (BMAS, 2014), which largely emphasised preparing students as future business teachers. The revised curriculum now establishes a dual mandate: to equip students with pedagogical competencies for teaching business subjects and to prepare them for self-reliance through entrepreneurial venture creation. Central to this reform is the integration of technological innovation into the Business Education programme, thereby aligning it with national goals for digital transformation

and youth empowerment. However, as ambitious as this curriculum shift may be, its success depends heavily on how well lecturers translate its intentions into classroom practice.

A key concern is that curriculum effectiveness is often constrained by the quality of its implementation. If lecturers continue to rely on conventional teaching approaches or limit their use of technology to content delivery alone, the transformative goals of the CCMAS may not be realised. Hence, the problem of this study is to investigate whether EdTechpreneurial tools that can empower students to build and apply business knowledge through technology are being actively deployed in classrooms. This is because without such assessment, the curriculum's promise to produce both competent teachers and innovation-driven entrepreneurs risks remaining on paper rather than manifesting in practice.

Purpose of the Study

The major aim of this study is to assess the integration of EdTechpreneurial Pedagogies in Business Education for Self-Employment readiness of the students in universities in Lagos State. Specifically, this study is guided by three objectives, which are to:

1. **determine the level of students' exposure to EdTechpreneurial pedagogies in Business Education courses.**
2. **identify the types of EdTech tools and platforms lecturers use in the delivery of Business Education content.**
3. **evaluate the perceived impact of EdTechpreneurial pedagogies on students' preparedness for self-employment.**
4. **identify the challenges students face in benefiting from the integration of EdTechpreneurial pedagogies in Business Education**

Research Questions

Four questions were answered in this study as follows:

1. What is the level of students' exposure to EdTechpreneurial pedagogies in Business Education courses.
2. What types of EdTech tools and platforms are lecturers using in the delivery of Business Education content?
3. **What is the perceived impact of EdTechpreneurial pedagogies on students' preparedness for self-employment?**
4. **What challenges do students face in benefiting from the integration of EdTechpreneurial pedagogies in Business Education**?

Research Hypotheses

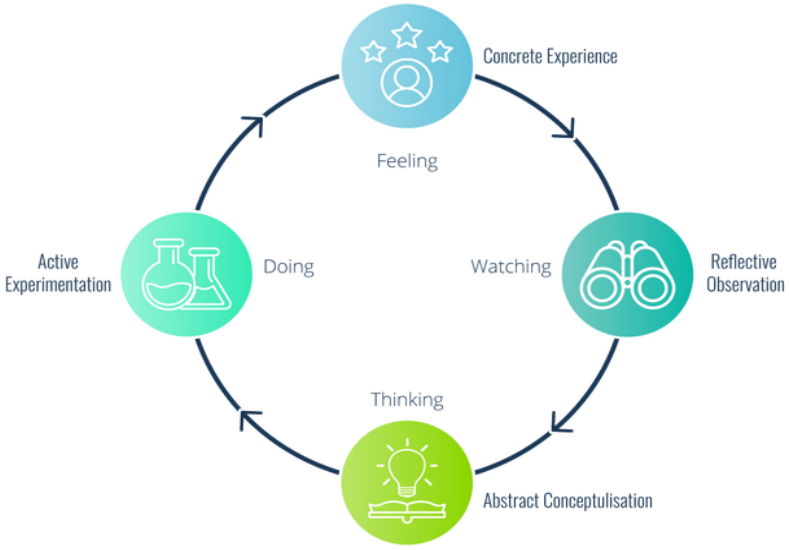
One null hypothesis was tested in this study:

Ho_1: There is no statistically significant relationship between students' exposure to EdTechpreneurial pedagogies and their perceived preparedness for self-employment.

Theoretical Framework: Kolb's Experiential Learning Theory

The current study is grounded in David Kolb's Experiential Learning Theory (ELT), a dynamic model that explains how learners acquire and apply knowledge through experience. Kolb (1984), drawing from Dewey, Piaget, and Lewin, proposed that effective learning is a cyclical process involving four stages: Concrete Experience, Reflective Observation, Abstract Conceptualisation, and Active Experimentation.

Figure 1: Kold's Experiential Learning Theory



In the Concrete Experience stage, students encounter new situations or reinterpret existing ones, such as engaging with EdTech tools like Canva or WhatsApp Business in a Business Education course. This is followed by Reflective Observation, where students reflect on how these tools were used by lecturers, and whether they helped them connect theory to enterprise-oriented practice. These reflections guide the Abstract Conceptualisation stage, where students build mental models or reframe their understanding of entrepreneurship and digital literacy, possibly through business simulations or e-commerce assignments. Finally, Active Experimentation involves applying these concepts, creating real or prototype business ventures using the tools they have engaged with. This cycle mirrors how EdTechpreneurial pedagogies should ideally function.

Kolb further identifies four learning styles that explain students' dominant preferences. Diverging learners, who excel at observation and imaginative thinking, would benefit from group reflections on tech-based business challenges. Assimilating learners, who prioritise conceptual clarity, thrive on structured digital content or LMS-based entrepreneurship models. Converging learners, who are solution-oriented, would engage best through task-based platforms like Trello. Accommodating learners who prefer hands-on experience is likely to respond well to practical tool use, such as setting up online storefronts.

ELT is appropriate for the current study as it validates the need to assess whether Business Education lecturers provide sufficient exposure, reflection, conceptual development, and application opportunities through EdTech tools, key in developing graduates prepared for self-employment in a tech-driven economy.

Review of Empirical Related Studies

Recent empirical investigations in Business Education in Nigeria have emphasised the growing necessity of embedding entrepreneurial capacity into pedagogical delivery. Among the most relevant empirical contributions is the study by Edeh, Odunukwe, Abubakar, Ozurumba, Adeleye and Yumma (2022), which assessed strategies for effective implementation of the Business Education curriculum for self-reliance in South-East Nigeria. This study used a descriptive survey design among university lecturers and identified several barriers to effective curriculum implementation, including limited technological resources and low staff training in entrepreneurship-infused delivery. While the study provided valuable institutional insight, its lecturer-focused orientation left out student perspectives, which are critical in determining how curriculum implementation translates into actual exposure and self-employment preparedness. Additionally, no specific technological tools were identified as core to entrepreneurial training, making it difficult to assess their integration level.

Alao and Alao (2022) provided one of the few student-centered investigations by exploring the impact of innovative pedagogies on the entrepreneurial empowerment of Business Education students in Lagos tertiary institutions. Their findings emphasized the importance of experiential learning, practical exposures, and digital collaboration tools. However, the study fell short of naming or categorizing specific EdTech tools employed by lecturers or students. It also did not clarify whether the entrepreneurial empowerment students experienced resulted directly from pedagogical exposure or personal initiative. This ambiguity underlines a gap in determining whether EdTechpreneurial practices are embedded in the curriculum or merely co-curricular experiences. The current study addresses this by interrogating students' exposure to such pedagogies as delivered through the curriculum and by their lecturers.

In another critical analysis of technology integration in Nigerian secondary schools, Chidiebere (2020) focused on infrastructural readiness and teachers' attitudes. Though not in the university context, the study offers foundational insight into systemic issues likely mirrored at the tertiary level, such as inadequate funding and limited teacher competencies. Importantly, the study did not consider the entrepreneurial outcomes of technology integration or how tool selection links with self-employment competencies. Thus, the transition from basic ICT familiarity to strategic EdTech use for entrepreneurial training remains uncharted, especially from the student experience angle, which the current study now foregrounds. Similarly, Nwokike and Chukwuma (2019) investigated the integration of new technologies in teaching Business Education in public universities in Enugu State. Their study revealed that the lack of new technology tools and inadequate competencies among lecturers significantly constrained digital adoption. Tools referenced were general-purpose technologies and did not include entrepreneurial platforms such as Google Sites, Canva, or Paystack. Moreover, their study relied solely on business educators' responses, without exploring the learner's side of implementation. By not capturing whether students actually benefited from any implemented technologies, the study highlighted the need for further empirical investigation into how teaching practices translate into learner empowerment, an issue directly tackled by the current study.

The study by Enang and Okute (2019) emphasised the application of new technologies for skill acquisition in tertiary Business Education. It examined how flipped classrooms, personalised learning, and technology-enabled collaboration could support Business Education outcomes. This research offered a more conceptual exploration, citing potential benefits rather than empirically testing actual classroom application or student outcomes. It lacked field data and did not involve either lecturers or students as respondents, which limits its practical implications. Furthermore, while tools like the flipped classroom were mentioned, there was no linkage to entrepreneurship-specific platforms or how students use such tools for business creation.

In comparing these studies, a few commonalities and critical gaps emerge. First, most lecturer-focused studies underscore infrastructural and competence-related barriers but fail to investigate what students actually receive in practice. Second, student-centred studies hint at entrepreneurial gains but do not tie these to specific EdTech tools or assess their alignment with curriculum delivery. Third, conceptual studies and the digital pedagogy paper offer valuable theoretical insights but lack empirical testing in classroom settings. Moreover, across all the studies, none adopt a dual-focus approach combining technology use with entrepreneurial intent through the lens of students who are at the final phase of the Business Education programme, making them the most reliable evaluators of curriculum implementation. There is also limited clarity on which EdTech tools are actually used in classrooms and whether they are aligned with entrepreneurial skill acquisition.

Methodology

This study adopted a quantitative research design. The study focused on 142 and 45 final-year (400-level) students in the Business Education programme of the University of Lagos and Lagos State University, respectively, who are considered best positioned to assess cumulative exposure to entrepreneurial-oriented EdTech tools. A census sampling technique was employed, involving all the 187 400-level students enrolled in the 2024/2025 academic session of the two universities. This choice was informed by the manageable population size and the need for comprehensive coverage of student perspectives. Data collection was conducted using a researcher-designed questionnaire titled "Students' Assessment of EdTechpreneurial Pedagogies in Business Education Questionnaire (SAEPEBEQ)".

The instrument was divided into five sections. Section A gathered demographic data (3 items). Section B examined students' level of exposure to EdTechpreneurial pedagogies, featuring 5 items that measured frequency and intensity of engagement with technology-supported entrepreneurial learning experiences. Section C focused on identifying the types of EdTech tools and platforms lecturers have used during instructional delivery. This section included 7 items targeting tools such as Canva, Google Sites, Instagram shop, Facebook and WhatsApp Business. Section D assessed students' perception of the impact of EdTechpreneurial pedagogies on their self-employment readiness, using 5 items designed to evaluate confidence in business planning, digital branding, and launching ventures. Lastly, Section E captured the challenges students face in benefiting from these pedagogies. This section comprised 5 items addressing issues such as digital skill gaps, infrastructure, cost, and lecturer support. All items were rated on a 4-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1), except for section C, which was rated using yes or no response pattern.

For reliability testing, 20 students from the 300-level cohort of the University of Lagos were used in a pilot study. The internal consistency of the instrument yielded a Cronbach's Alpha coefficient ranging from 0.720 to 0.744 for the four sections, indicating an acceptable level of reliability. All data collected were analysed using descriptive statistics, particularly, frequency count and percentage for answering the research questions, and Pearson correlation was used to test the null hypothesis at a 0.05 level of significance.

Results

Research Question 1: What is the level of students' exposure to EdTechpreneurial pedagogies in Business Education courses?

Table 2: Students' Exposure to EdTechpreneurial Pedagogies in Business Education Courses

S/N	Item	SD (%)	D (%)	A (%)	SA (%)
1	I have been taught business-related skills using digital tools in my courses.	6 (4.2)	12 (8.4)	83 (58.0)	42 (29.4)
2	I am familiar with how to use digital tools through class teaching.	7 (4.9)	10 (7.0)	100 (69.9)	26 (18.2)
3	During my course of study, my lecturers involve all students in projects that require using digital tools to simulate business.	9 (6.3)	27 (18.9)	77 (53.8)	30 (21.0)
4	Exposure to digital-based entrepreneurship activities in class has helped me understand entrepreneurship.	10 (7.0)	13 (9.1)	85 (59.4)	35 (24.5)

Note: SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SD = Strongly Disagree

Table 2 presents a clear picture of students' exposure to EdTechpreneurial pedagogies in Business Education courses. It indicates a high level of student exposure to EdTechpreneurial pedagogies in Business Education courses. Across all items, the majority of respondents selected Agree or Strongly Agree, showing consistent engagement with digital tools for business learning. Notably, 87.4% reported being taught business-related skills using digital tools, while 88.1% were familiar with digital platforms through classroom teaching. Similarly, 74.8% confirmed participation in projects requiring digital tool use to simulate business activities, and 83.9% agreed that exposure to digital-based entrepreneurship activities enhanced their understanding of entrepreneurship. These findings suggest that EdTechpreneurial strategies are actively embedded in course delivery, equipping students with both theoretical knowledge and practical experience. Hence, students appear to receive substantial exposure to technology-driven entrepreneurial learning, positioning them to apply digital tools effectively in real-world business contexts.

Research Question 2: What types of EdTech tools and platforms are lecturers using in the delivery of Business Education content?

Table 3: Students' Exposure to Specific EdTech Tools for Business Education

S/N	EdTech Tool and Purpose	No (n, %)	Yes (n, %)
1	Canva (for design, branding, logo creation)	110 (76.9)	33 (23.1)
2	WhatsApp Business (for teaching advertising & marketing)	94 (65.7)	49 (34.3)
3	Facebook Business (for teaching advertising & marketing)	94 (65.7)	49 (34.3)
4	Google Sites or blogs (for building business pages or portfolios)	104 (72.7)	39 (27.3)
5	Instagram Shop (to showcase products and direct users to external websites or physical stores for transactions)	102 (71.3)	41 (28.7)
6	Wix / WordPress (for practicing business website design and e-commerce training without coding)	82 (57.3)	61 (42.7)
7	Facebook Marketplace (for digital entrepreneurship and product testing)	98 (68.5)	45 (31.5)

Table 3 indicates that most lecturers are not using the listed EdTech tools and platforms in delivering Business Education content, as shown by the consistently higher "No" responses compared to "Yes" responses. For instance, Canva has a low usage rate of 23.1%, while Google Sites/blogs and Instagram Shop are used by only 27.3% and 28.7% of students' lecturers, respectively. Even the relatively more used tools, Wix/WordPress (42.7%), Facebook Business (34.3%), and WhatsApp Business (34.3%), still show that the majority of students (over half) report no exposure to them.

However, respondents provide additional opinions as to what EdTech tools are being utilised to teach them business education courses as follows:

Table 4: Other Edtechpreneur Tools used in Business Education

S/N	EdTech Tool / Platform	Frequency	Percentage (%)
1	TikTok	53	37.1
2	Desktop Publishing; Microsoft Word, PowerPoint & Excel; Google Workspace, Mailchimp, Laptop; Jumia/AliExpress	84	58.7

However, the additional tools students say their lecturers "normally use" show a different pattern. The most frequently mentioned tools, TikTok 53 (37.1%) while useful for general communication, content creation, or data processing, are not primarily entrepreneurial training tools within the Business Education framework. While, the majority 84 (58.7%) commented that Microsoft Office applications, Google Workspace, Mailchimp, laptops, and e-commerce sites like Jumia/AliExpress were used in the process of teaching them. While some of these can support business-related tasks, they are largely general productivity or communication tools rather than platforms that provide authentic entrepreneurial practice.

This pattern suggests that although lecturers may be using various digital tools in class, the integration of core entrepreneurial EdTech tools designed to develop students' skills in branding, marketing, e-commerce, and digital entrepreneurship remains limited. The additional tools list shows a stronger emphasis on administrative and presentation tasks rather than immersive, skills-based experiences in areas like online branding, product development, customer engagement, or digital sales. As a result, students may not be getting adequate exposure to practical, market-relevant digital entrepreneurship platforms, which are central to building 21st-century vocational skills in Business Education.

Research Question 3: What is the perceived impact of EdTechpreneurial pedagogies on students' preparedness for self-employment?

Table 5: Students' Perception of the Impact of EdTechpreneurial Pedagogies on Preparedness for Self-Employment

S/N	Item	SA (%)	A (%)	U (%)	D (%)	SD (%)
1	Due to my classroom exposure, I now feel confident in using digital tools to start my own business.	4 (2.8)	8 (5.6)	19 (13.3)	90 (62.9)	22 (15.4)
2	The tools introduced in class have motivated me to think about starting my own business after graduation.	2 (1.4)	10 (7.0)	13 (9.1)	91 (63.6)	27 (18.9)
3	My classroom experiences have developed my skills to run a business using digital platforms.	5 (3.5)	17 (11.9)	10 (7.0)	89 (62.2)	22 (15.4)
4	EdTechpreneurial strategies in my courses have helped me connect theory to real-life business.	2 (1.4)	8 (5.6)	9 (6.3)	98 (68.5)	26 (18.2)
5	Owing to my classroom experience, I now feel more prepared to launch a digital business immediately after graduation.	3 (2.1)	17 (11.9)	17 (11.9)	84 (58.7)	22 (15.4)

Note: SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SD = Strongly Disagree

Table 5 reveals a predominantly negative perception among students regarding the impact of EdTechpreneurial pedagogies on their preparedness for self-employment. For Item 1, only 8.4% (SA = 2.8%, A = 5.6%) of students agreed that their classroom exposure made them confident in using digital tools to start their own business, while a substantial 78.3% (D = 62.9%, SD = 15.4%) disagreed, and 13.3% were undecided. Similarly, in Item 2, just 8.4% agreed that the tools introduced in class motivated them to start a business after graduation, with 82.5% expressing disagreement and 9.1% remaining undecided. For Item 3, only 15.4% agreed that their classroom experiences developed the skills needed to run a digital business, whereas 77.6% disagreed and 7.0% were undecided. In Item 4, the majority (86.7%) disagreed that EdTechpreneurial strategies helped them connect theory to real-life business situations, with only 7.0% agreeing and 6.3% undecided. Finally, Item 5 showed that just 14.0% felt more prepared to launch a digital business immediately after graduation, compared to 74.1% who disagreed and 11.9% who were undecided.

Hence, the findings suggest that EdTechpreneurial pedagogies, as currently implemented, are perceived by most students as having limited impact on their readiness for self-employment. While a small fraction acknowledged increased confidence, motivation, or skill development, the overwhelming majority disagreed, indicating a possible gap between the intended outcomes of these pedagogies and their actual influence on students' entrepreneurial preparedness. This points to a need for more practical, immersive, and mentorship-driven approaches that bridge theory with real-world entrepreneurial practice.

Research Question 4: What challenges do students face in benefiting from the integration of EdTechpreneurial pedagogies in Business Education?

Table 6: Perceived Challenges Affecting the Use of EdTechpreneurial Pedagogies for Self-Employment Preparedness

S/N	Item	SD (%)	D (%)	A (%)	SA (%)
1	I lack personal access to laptops or smartphones for business learning.	27 (18.9)	60 (42.0)	38 (26.6)	18 (12.6)

S/N	Item	SD (%)	D (%)	A (%)	SA (%)
2	Poor internet connectivity limits my use of digital business tools in learning.	13 (9.1)	25 (17.5)	74 (51.7)	31 (21.7)
3	Most lecturers avoid using digital tools in teaching entrepreneurial content.	10 (7.0)	46 (32.2)	72 (50.3)	15 (10.5)
4	The university does not provide enough digital resources or access to entrepreneurship platforms.	8 (5.6)	31 (21.7)	67 (46.9)	37 (25.9)
5	I find it hard to understand or use some digital tools introduced in class.	21 (14.7)	63 (44.1)	50 (35.0)	9 (6.3)

The results in Table 6 highlight several significant challenges that students face in benefiting from the integration of EdTechpreneurial pedagogies in Business Education. For Item 1, a majority of students (60.9%) disagreed with the statement that they lacked personal access to laptops or smartphones, while 39.2% agreed. This indicates that although access to devices is not a universal challenge, a considerable minority still experiences this barrier, which could limit their ability to fully engage with digital entrepreneurial learning. Item 2 reveals that poor internet connectivity is a major challenge, with 73.4% (Agree = 51.7%, Strongly Agree = 21.7%) confirming its negative impact on their use of digital business tools, while only 26.6% disagreed. In Item 3, over half of the respondents (60.8%) agreed that most lecturers avoid using digital tools in teaching entrepreneurial content, suggesting that instructional practices may not consistently support EdTech-driven entrepreneurship learning.

Item 4 further emphasises institutional limitations, with 72.8% of students agreeing that their university does not provide enough digital resources or access to entrepreneurship platforms, highlighting a critical infrastructural gap. Finally, Item 5 shows that 41.3% of students struggled to understand or use some digital tools introduced in class, while the majority (58.8%) did not perceive this as a challenge. This indicates that while technical difficulty is not as widespread as other issues, it still affects a substantial proportion of students. Hence, the findings indicate that the key challenges to benefiting from EdTechpreneurial pedagogies include poor internet connectivity, insufficient institutional provision of digital resources, and inconsistent use of digital tools by lecturers. While device ownership is relatively less problematic, its absence still affects a notable minority.

Test of Hypothesis

Ho_1: There is no statistically significant relationship between students' exposure to EdTechpreneurial pedagogies and their perceived preparedness for self-employment.

Table 7: Correlation Analysis showing relationship between students' exposure to EdTechpreneurial pedagogies and their perceived preparedness for self-employment

Variable	N	$\bar{X}$	SD	df	Cal r-value	p-value	Decision
Exposure to EdTechpreneurial Pedagogies (EEP)	143	3.82	.793	141			Ho

			.249	.056	Accepted
Entrepreneurial Preparedness for Self-Employment	3.84	.702			

***Significant P< .05**

Table 7 shows the Pearson correlation analysis between students' exposure to EdTechpreneurial pedagogies (EEP) and their entrepreneurial preparedness for self-employment. The calculated correlation coefficient (r = 0.249) indicates a weak positive relationship between the two variables. However, the p-value (.056) is greater than the 0.05 significance threshold, meaning the relationship is not statistically significant at the 5% level. This implies that variations in students' exposure to EdTechpreneurial pedagogies do not significantly predict their perceived preparedness for self-employment. Consequently, the null hypothesis (Ho_1), which states that there is no statistically significant relationship between students' exposure to EdTechpreneurial pedagogies and their perceived preparedness for self-employment, is accepted.

Discussion of Findings

The findings of this study, when examined alongside existing literature and Kolb's Experiential Learning Theory, consistently point to a single systemic weakness in the teaching of Business Education in Nigerian universities: EdTechpreneurial pedagogies are being introduced in name, but lack the depth and practical application needed to truly prepare students for entrepreneurship. Research question one indicates that students report high exposure to EdTechpreneurial pedagogies, suggesting that digital tools feature in course delivery. However, research question two reveals that lecturers largely rely on general productivity tools such as Microsoft Office and Google Workspace, rather than specialised, market-relevant entrepreneurial platforms like Canva, Google Sites, or e-commerce tools. This pattern reflects earlier findings by Nwokike and Chukwuma (2019) and Edeh et al. (2022), who identified limited lecturer competence and tool selection as key barriers to effective entrepreneurship-oriented technology use. Such a tool choice limits students' opportunities to engage in authentic, venture-driven activities and undermines the entrepreneurial intent embedded in the CCMAS curriculum (NUC, 2023).

Kolb's Experiential Learning Theory helps explain why this tool gap results in the research question three, where students overwhelmingly feel unprepared for self-employment. While the Concrete Experience stage is partially met through exposure to digital tools, subsequent stages, particularly Active Experimentation, remain underdeveloped. Students are rarely tasked with creating real or prototype businesses using the tools, preventing the full cycle of learning that transforms theory into competence. This echoes Alao and Alao's (2022) observation that entrepreneurial empowerment often stems from personal initiative rather than structured pedagogical exposure. The fourth research question highlights the enabling conditions behind this shortfall: poor internet connectivity, inadequate institutional resources, and limited lecturer adoption of entrepreneurial tools, challenges also noted by Chidiebere (2020) and Enang & Okute (2019). These systemic constraints make sustained, practice-based engagement with entrepreneurial technologies difficult.

Finally, the non-significant correlation between exposure and preparedness confirms that nominal exposure alone does not build entrepreneurial capability. In line with Olatunji and Ajero's (2022) argument, the study shows that without intentional, experiential, and tool-specific integration, EdTechpreneurial strategies risk remaining theoretical, leaving the employability and innovation goals of Business Education unmet.

Conclusion

This study concludes that while EdTechpreneurial pedagogies are visibly integrated into Business Education, their implementation lacks the depth and authenticity required to develop entrepreneurial competence. Findings show high student exposure to digital tools but a heavy reliance on generic platforms rather than market-relevant entrepreneurial

technologies. This gap, combined with infrastructural deficiencies, limited lecturer adoption, and inadequate practical engagement, contributes to low self-employment preparedness. The non-significant correlation between exposure and readiness reinforces that theoretical familiarity alone is insufficient. Without stronger integration of hands-on, skills-based EdTechpreneurial practices supported by institutional resources, Business Education risks producing graduates unready for the demands of entrepreneurship.

Recommendations

Given the findings of this study, it was recommended that:

1. Improve Institutional Infrastructure and Support: Institutions must prioritise investment in reliable internet connectivity, updated digital facilities, and dedicated technical support. Providing access to licensed, market-relevant entrepreneurial software and establishing innovation hubs or digital labs will ensure students can engage meaningfully with authentic business tools.

2. Train Lecturers to Identify and Use EdTechpreneurial Tools: Targeted professional development programmes should equip lecturers with the skills to identify, evaluate, and integrate genuine EdTechpreneurial platforms into teaching. Training should focus on both technical proficiency and pedagogical strategies, enabling lecturers to design practical, skill-based activities that mirror real-world entrepreneurial processes and foster student readiness for self-employment.

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AI FOR MULTILINGUAL NLP AND INDIGENOUS LANGUAGE PROCESSING IN AFRICAN CONTEXTS

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Abstract

The linguistic diversity of Africa presents both a challenge and a deep opportunity in the fields of Artificial Intelligence (AI) and Natural Language Processing (NLP). In this paper, the author presents arguments to support the importance of AI in enhancing sustainable digital transformation across African economies by processing multilingual and indigenous languages. We analyse the intricacies of low-resource languages, data scarcity, and ethical implications, as well as the potential changes brought about by AI-based solutions. By focusing on culturally competent and inclusive AI development, Africa can unlock considerable socio-economic potential, preserve its cultural heritage, and ensure fair access to information and services, ultimately leading to a truly inclusive digital future.

Keywords: Artificial Intelligence, Natural Language Processing, Multilingual NLP, Indigenous Languages, African Economies, Digital Transformation, Ethical AI, Language Preservation.

Introduction

The omnipresence of Artificial Intelligence (AI) and Natural Language Processing (NLP) is definitely changing the world, and these trends are still causing digital transformations in numerous sectors as never before. It is as enormous a wave of change as is the promise of progress and innovation that it carries, but it is also a wave of change that is desperately needed: the fair distribution of the fruits of these changes in the multi-linguistic, multi-cultural world fabrics. It is a continent that is exceptionally linguistically diverse, and Africa is uniquely placed to harness the strength of AI in advancing an inclusive digital agenda (Nekoto et al., 2020; Oladipo and Oyewole, 2024).

Africa is the home to approximately 1,250-3,000 living languages, which make up a considerable portion of the world's linguistic heritage (Ethnologue, 2024). It is only when such sophisticated AI systems are thoughtfully designed and built to comprehensively comprehend, manipulate and produce content in the multiplicity of African native languages that the deep promise of AI in turning Africa into a sustainable economic and societal development hub can be fully realised. The major and extensive developments that are appealing to the different people of the continent are not only technically possible but are a necessity (Adelani et al., 2022).

The centrality of making AI a priority in the context of multilingual NLP and indigenous language processing as a prerequisite in creating robust, resilient and sustainable digital transformation frameworks within the African economies is undoubtedly confirmed in this position paper. We shall elaborate on the intricacies and the vast untapped potential of the rich African linguistic fabric. We will discuss how the state-of-the-art AI approaches are implemented to overcome the overwhelming challenge of poor-resource languages, the omnipresent issue of the lack of data, and the cultural complexity of the language environment inside the continent (Nekoto et al., 2020).

Our central thesis is that a conscious, long-term, and significant investment in the development of AI solutions that are deliberately tailored to the specific linguistic diversity of Africa will become a new horizon of economic empowerment, ensure the essential preservation of invaluable cultural heritage, and significantly expand the access of all people to the most important information and other essential services. This type of targeted development is not only advantageous but a necessity that will drive a truly inclusive digital transformation that will positively impact all spheres of African society and result in equal growth and opportunity.

The current state of multilingual NLP will be described in detail later in the paper, where the specific problems, along with the enormous significance of the indigenous language processing in the African setting, will be identified. Then, we will introduce novel AI-based solutions and approaches sensitive to these special conditions. Furthermore, we will critically address the ethical issues and those significant socio-economic opportunities which the responsible and conscientious use of AI in this vital field would generate, and emphasise the essential role of concerted efforts by governments, academic and scientific communities, industrial leaders and grassroots movements in building a successful, fair, and linguistically inclusive digital future of African economies.

Statement of the Problem

Despite the potential transformative power of AI and NLP, a notable gap persists in their application and performance within the global linguistic landscape. Although high-resource languages (English, French, Mandarin, etc.) have access to large digital corpora, sophisticated models, and strong research infrastructures, most languages in the world, especially indigenous African languages, are extremely under-resourced. Such a severe imbalance leads to a sharp digital divide, which in effect reduces access to essential information, necessary services, and important economic opportunities to millions of people who mainly speak their native languages. The future path of AI development, unless intentionally and carefully directed towards linguistic inclusivity, poses the risk of reinforcing existing inequalities and pushing already vulnerable groups to the periphery (Nekoto et al., 2020; Oladipo and Oyewole, 2024).

It is a complex issue that goes beyond the fact that there is a lack of digital linguistic data. It includes the distinct structural complexities of most African languages, such as rich morphology, complex tonal variation, and the ubiquitous code-switching, which present significant challenges to existing NLP models (Adelani et al., 2022). Moreover, various historical influences, including colonial legacies and inadequate investment in local research and development, have played a major role in creating a widespread absence of standard orthographies and a small digital footprint of many indigenous languages. Unless there are interventions and a united, coordinated effort to develop AI solutions that are culturally and linguistically sensitive, the digital transformation of Africa will continue to be a fundamentally incomplete process that does not see the full potential of the human capital and the priceless linguistic legacy of the region truly brought to bear to ensure its sustainable development.

Literature Review

Machine learning (and deep learning, in particular) has transformed the reality of Natural Language Processing dramatically, developing advanced models able to process and synthesize human language. The Multilingual NLP critical subfield attempts to extend these capabilities to a broad variety of very different linguistic systems that contribute to the ease of world communication and information access. Previously multilingual NLP was focused on parallel corpora and rule-based systems, but giant pre-trained models like multilingual BERT (mBERT) and XLM RoBERTa relegated their predecessors to history (Devlin et al., 2019; Conneau et al., 2020). These transformer-based architectures are trained with large sets of texts in multiple languages, and can learn common representations of languages and can transfer learning to low-resource languages, where the knowledge learned with high-resource languages can be applied to low-resource languages.

In parallel with all that, there exists a set of natural challenges of multilingual NLP that are particularly acute within the context of linguistic diversity in Africa. Words that change in significant ways to reflect grammatical information pose a major challenge to the traditional NLP techniques (Lewis et al., 2016). The rules of complex word formation, such as extensive compounding, cannot be tokenised and processed using simple methods (Lewis et al., 2016). Furthermore, not all writing systems have distinct boundaries between words, necessitating sophisticated and, in most instances, machine learning-driven tokenisers (Lewis et al., 2016). Variations in spelling and the endemic issue of data insufficiency, especially in low-resource languages, significantly constrain the practicality and usefulness of data-heavy deep learning models (Nekoto et al., 2020). Besides the structural complexities, cultural context, nuances, and code-switching phenomena, the issue of developing really effective and culturally sensitive NLP systems to be implemented in different populations is complicated even more (Nekoto et al., 2020).

African linguistics is a vast and varied place, with some estimating up to 1,250 to over 3,000 extant languages (Ethnologue, 2024; Gordon, 2005). As a cultural resource, this diversity presents unique challenges to digital inclusion. The majority of native languages in Africa were found to be low-resource languages that do not have large digital corpora, annotated datasets, or computational lexicons, just like major world languages (Nekoto et al., 2020). This is supported by the reality that most languages lack standard orthographies and they largely lack digital presence, which makes data collection and annotation a resource-demanding and costly endeavor (Nekoto et al., 2020). Ethical issues regarding data ownership, data privacy, and fair representation also become central since historical episodes of exploitation have been observed (Nekoto et al., 2020; Oladipo and Oyewole, 2024).

The consideration of new AI-based solutions is taken to address these issues. Masakhane is one of the best examples

of community engagement and crowd sourcing, which speeds up data collection and stimulates local knowledge and ownership (Masakhane, 2020). Examples of transfer learning and data augmentation techniques that permit high-prepared, pre-trained models include back-translation and synthetic data generation. Small low-resource datasets can be successfully fine-tuned on resource languages (Adelani et al., 2022). Another significant step toward the approach of addressing the specifics of the language and reducing foreign dependency is the introduction of African-specific Large Language Models, such as InkubaLM by Lelapa AI (Lelapa AI, 2023). Self-supervised learning based on unlabeled data, specifically, fares best in low-resource settings, where models can learn rich linguistic representations without extensive amounts of annotation.

The NLP AI application of multilingual and indigenous application can be used in numerous sectors within Africa with expansive potential. Machine translation can help lessen communication barriers and facilitate easier trading and exchange of information among countries in Africa (Adelani et al., 2022). Digital inclusion, especially among low-literacy populations, must include proper Automatic Speech Recognition (ASR) and Text-to-Speech (TTS) systems to facilitate voice-controlled applications and localised content (Nweke and Ofoegbu, 2025). Furthermore, NLP can enhance information extraction, question answering, sentiment analysis and provide localised educational and healthcare services, which will ultimately result in economic empowerment, cultural preservation and increased access to essential services (Nekoto et al., 2020). However, these opportunities must be pursued with a fair degree of caution in terms of ethical considerations, including algorithmic bias, data privacy, and fair distribution of benefits, to achieve a truly inclusive and sustainable digital transformation (Nekoto et al., 2020; Oladipo and Oyewole, 2024; UNESCO, 2020).

Conclusion

The linguistic variety of Africa is so vast that it is both a challenge and an opportunity that AI and NLP have never encountered before. As noted in this paper, AI in multilingual NLP and indigenous language processing can play a crucial role in establishing sustainable digital transformation infrastructures within African economies. We have outlined the multicomplexity of multilingual NLP, which, when applied in the context of low-resource native languages in Africa, is further compounded and necessitates specific solutions and approaches.

Making an effort to develop AI solutions that are not only technologically valid but also culturally sensitive and ethically sound can help overcome these complexities. Africa can leverage its linguistic history as a driver of inclusive development by building community-based data generation, exploiting new model architectures like pre-trained multilingual models and African-specific LLMs, and by focusing on real-world applications within fields such as education, healthcare, and agriculture. The most important step in the transformative promise of AI benefiting Africans and building a successful and equitable digital future is responsible AI development, with the priorities of privacy and fairness of algorithms and equitable distribution of benefits.

Recommendations

To achieve the full potential of AI in multilingual NLP and indigenous language processing in Africa, the following steps can be taken:

1. Invest heavily in data collection and annotation initiatives by local communities, with ethical data management and adequate reward to linguistic contributors.
2. Invest more in research and development of strong AI models that are African language specific, such as the ongoing development of African-specific large language models (LLMs), further development of African-specific Automatic Speech Recognition (ASR) and Text-to-Speech (TTS) systems.
3. Develop educational initiatives and research centres to establish sustainable local capabilities and cultivate AI and language technologies expertise.
4. Urge policymakers to adopt regulatory frameworks that enable linguistic diversity, encourage innovation, and provide fair access to AI technologies to all groups in society.

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EDUTECHPRENEURSHIP: PHOTOCOPY AND VIDEO PRODUCTION FOR INCOME RAISING IN THE WORKPLACE

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Abstract
Educational Technology can be seen as a systematic approach, which is a self-adjusting combination of interacting with people, and the equipment so designed by man to accomplish some predetermined objective. Entrepreneurial education is designed to teach the skills and knowledge that is needed to be known before embarking on a new business venture. The training in entrepreneurial education may initially be perceived as a cost in terms of time and money but it would eventually be appreciated. Photocopy is a print media, a visual medium, and digital document creation. The machine used in making photocopies is referred to as a photocopier. A photocopier can be referred to as electronic duplication that focuses on a reproduced image on plain bond paper. It uses scientific knowledge to function. Video production encapsulates all that comes with an idea for a show, film, or event as it gets to the final product in the consumer's hands. Video production entails a lot of activities. What is seen on the television or film screen is the end product of video production work. Video production is also called videography. Photocopy and Video Production are part of the course contents taught in Educational Technology in Colleges of Education which when best learnt become entrepreneurial skills forming a source of income. This paper therefore seeks to examine photocopy and video production as learning experiences that learners are exposed to under educational technology as skills which if effectively and efficiently acquired can form entrepreneurial skills. How this serves as a source in the workplace will also be examined. Photocopy and video production, if well learnt and practiced can be regarded as a sustainable source of income in the workplace. It can be suggested to the stakeholders that photocopy and video production be taken as forming part of the entrepreneurial skills.
Keywords: Photocopy, video production, educational technology, entrepreneurship and workplace.

Introduction

The National Policy on Education is definite that the defining character of an educated person is the competence to live and work successfully in society. The proof of being educated is provided by possession of these competencies. Individuals who lack life skills and competencies are prone to suffer identity crises and social disorientation. He further stated that, the curriculum at each stage of formal education, from primary to tertiary, is therefore geared towards inculcating civilized and enlightened mode of living as well as competencies. Even the federal government devoted ₦210 bn or 13 percent of the total budget for 2008 education alone, apart from another ₦39.7bn earmarked as intervention fund for the Universal Basic Education Programme. The education budget 2008 represents about 12 percent increase over the 2007 ₦188bn (Owoseni, 2011).

We learn from our experience and this is why we are able to withstand the shock of learning from nature. A lot of man's activities emanate from his ability to think, acquire knowledge and use his natural experiences and native intelligence to solve the problems that confront him daily. Therefore, when you are able to devise solution to a given problem through the thought process, you have invariably applied technology. Technology has made the approach to the giving and receiving of instruction easy through the utilization of various media. It is however worth remembering that the human element in all educational processes is primary, while the technical element is in almost all cases secondary (Adeyanju, 2013). This being the case, good teaching and effective learning are considered to be parts and parcel of human professional role. Simply put, the thought of how media can assist in the teaching and learning process

is technology on its own. Similarly, the development of selected media for doing the actual teaching such that the desired learners' outcomes are achieved is educational technology.

Edutechpreneurship are three words coined together which are Educational Technology and Entrepreneurship. The term technology simply describes the expert application of scientific knowledge in problem solving. It is also referred to as the technique or method of doing something expertly. Educational Technology is concerned with the problem of an educational context and it is characterized by its disciplined approach to a creative organization of resources for learning. Educational technology is also concerned with the effective utilization of resources, equipment and materials, which are essential for the purpose of improving on teaching and learning processes. The equipment and materials, which may be hardware and software are mostly used by technologists for adequate enhancement of teaching and learning in and out of school.

Educational technology is defined as media borne out of communication revolution that the teacher uses for instructional purposes including the use of gadgets. Ogunranti (1982) in Adeyanju (2013), sees it as principles and methods which bring together men and resources in an effort to effectively find solution to educational problems. Educational technology is a term used to describe a variety of material and devices designed to provide educators with component parts of a system that will enable them to communicate more effectively with students and that will facilitate student learning.

Education remains a vital transformational tool and formidable instrument for socio-economic empowerment, wealth creation, and employment generation, poverty alleviation and value orientation which government has talked about for so long now. Suffice it to be mentioned that education, training and experience can increase the supply of entrepreneurs by making available more skills which are suitable for entrepreneurial endeavour. Entrepreneurship education involves the willingness of persons to persistently pursue the opportunity to create wealth. This is done through innovative creation of products or services that will meet customers' needs, using scarce resources judiciously in a way that results in the growth of enterprise which satisfies the expectation of stakeholders. Business education in Nigeria should emphasize entrepreneurship consciousness for it to be relevant in achieving the right type of value and attitudes for the survival of the individual and the Nigeria society.

Having been successfully equipped with entrepreneurial skills through persistent education, one is ready to contribute positively in reducing unemployment by being self-employed. Entrepreneurship education stands out to be an antidote to unemployment having worked in line with today's educational policies that highlight self- reliance, self-employment, gainful employment and also consistent with the global awareness. Entrepreneurship education enhances the acquisition of necessary skills for gainful and self-employment. (Abiola and Ibitoye, 2023).

The National Economic Empowerment and Development Strategy (2004) document lends credence to the place of education by clearly explaining its role in self-reliance and development, Abiola and Ibitoye (2023) also supports this when they asserted that the goals of wealth creation or generation, poverty reduction and value re-orientation can only be attained and sustained through an efficient education system which impacts the relevant skills, knowledge, capacities, attitudes and values. In view of the benefits of education enumerated above, Nigeria has provided education for decades with abundant available manpower. However, what keeps agitating the nation endlessly borders on the slow and inefficient economy, near primitive democracy and violent social co-existence in society (NEEDS, 2004).

Education can be used to attain self-reliance and poverty eradication in African, as the true source of power in the world has not been the armies and not certainly diplomacy, but rather productive and qualitative education. President Lyndon Johnson of America officially launched a war against poverty in 1964 using education as the main weapon which he referred to as a worthwhile investment to harness his country's natural resources and the skills or potentialities of the people. In his message to congress, Johnson stated that the young man and woman who grows up without a decent education is often trapped in a life of poverty. Ojebode (2004) highlighting the above points noted that:

- A person (young or old) without a decent education is trapped in life of poverty as he would not have the necessary skills for survival in a complex society.

- Lack of qualitative education is a severe handicap that cripples a person as it breeds poverty which, in turn breeds despair, anger or lack of interest in anything except ones own worries.
- Functional education is the only means through which people can develop their skills, capacities or potentialities.
- Education is an investment that enriches the lives of the citizens and has a very high long rate of returns to the national economy.

Presently in Nigeria, the fundamental function of formal education is to produce a knowledge-based work force for national development. In this regard, the National policy on Education is definite that the defining character of an educated person is the competence to live and work successfully in society. It was observed in 2003-2008 Rolling Plans that Nigeria is currently faced with high rate of unemployment, underemployment, low productivity rising skill flight, depreciating real household income and the like. Over 70% of the unemployed in Nigeria are youths within 15-25 years of age (UNESCO, 2008). The unemployment rate of Nigerian university graduates is on the increase. Many of these graduates are found roaming round the street with no pay job(s). Majority of them are underemployed. This is not only a waste of human resources, but also a potential social time bomb to the Nigeria economy. It is against the above look of the role of education, as a Veritable Determinant for the Eradication of Unemployment in Nigeria.

Entrepreneurial education is the incorporation into the student syllabus steps involved in starting a new business based on a recognized business opportunity as well as operating and maintaining that business. The belief of some people is that entrepreneurship education does not need to be taught and therefore, an entrepreneur is born to be so. It should however be noted that for one to be a successful entrepreneur, he/she needs to learn the skills (Griffin and Hammis, 2001). Entrepreneurial education is designed to teach the skills and knowledge that is needed to be known before embarking on a new business venture. This would enhance necessary identification and avoidance of many pitfalls awaiting the less well trained and vigilant contemporaries. The training in entrepreneurial education may initially be perceived as a cost in terms of time and money but it would eventually be appreciated.

Entrepreneurial education also has a general education department as well as a professional entrepreneurship development and education component in Nigerian higher institutions, which is meant for all categories of students in the institution. Thus, all higher institutions in Nigeria integrates entrepreneurship education for all students irrespective of initial course admission and expect them to start their own businesses after graduation either on vocational or professional level to alleviate poverty and join in the scheme of improving their social-economy environment in particularly and beyond for self-economic emancipation. They are also fit to work closely with Entrepreneurs with Small and Medium Enterprises (SME). This will go a long way to eradicate unemployment in Nigeria.

Copying machines have in recent years become standard equipment in most offices such as sharp copier. Repro means copy and Graphics means pictures. Therefore the term reprography is used for all methods of reproducing copies. In other words, duplicating or reprographic process is a method whereby a master copy is prepared to obtain large number of copies. Training on the use of equipment needs to be provided for the acquisition of skills.

Photocopy and Video Production as Concepts

Copy is the reproduction of the exact copy of a material. Copier can be bought or rented. Copier is quicker than a typist and every detail on the original matter is faithfully reproduced. Important document can be copied before being dispatched. Photocopy is the quickest solution if an extra copy is needed. Reprography is simply referred to as the production of written, typewritten or drawn material or document through a variety of process. It could be termed copying from the original or master copy, the master copy could be handwritten, typewritten or drawn. The decision of whether to duplicate or copy is usually made by determining the number of copies needed (Oladeji, Olatoregun, Ayanrinde and Lawal, 2018). Photocopy is a digital document creation which is enabled with the use of a machine called photocopier or photocopy machine. Photocopier can be used to duplicate materials, reduce and enlarge documents, make diagrams, collate sheets and make transparencies. Photocopy has instructional values which include

producing educational materials in small and large qualities; producing materials quickly and cheaply; duplicating print materials as well as enlarging and reducing materials for teaching (Odusanya, and Ajibade, 2015).

Video is a communication tool that can carry the words of educators to far more individual learners than traditional face-to-face methods (Moore, 2020). Video production is a communication form that combines inputs from multiple source. Producers, writers, videographers, editors, and on-screen talent all contribute to the final message (Compesi and Gomez, 2017). When creating a video with an educational or advocacy purpose, content creators must remember that the subject-matter specialists and video production team members all contribute components of the final message (Moores, 2020).

Video allows experts to connect with a large, diverse audience on their own timetable through a variety of platforms. Video is recognised as superior to a traditional classroom in its ability to supplement speech with illustrative video, animations, and graphics, yet inferior to the classroom in its lack of interaction leading to feedback, questions, and relationship building (Jones, 1977) in Moore (2020). Video exists within a new paradigm of Digitally Mediated Learning (DML) environments. These DMLs exist as a recent evolution of distance education, allowing learners to interact through web-based applications including both customary computers and any variety of mobile devices (Lenove, 2011). This shift both allows and requires educators to adapt their programmes for life-long engagements with audiences increasingly likely to have never known life without the internet. As devices and networks continue to increase their video delivery capacity, educational planners must consider incorporating video elements lest they fall behind in a DML educational arm race.

New Enterprises for Making Ends Meet

It is the wish of every person to be successful in life. To have good success in life, a success that is outstanding, a success that is with distinction, a success that is with excellence, one has to meet certain criteria of a good success. These criteria which are factors that can be used to characterize good success, are self-fulfilment, meeting of parents and family expectations, meeting the expectations of the society and the nation of their citizens, making remarkable impact in life, living an exemplary life worthy of emulation and putting in place a succession that perpetuates the success. To have a good success in life requires the virtue of hard work. Hard work is defined by Longman's Dictionary of Contemporary English as working with a lot of effort. Hard work is synonymous to industry which means working hard. For any industrious persons, who is working hard to achieve outstanding success with an assignment, diligence and perseverance come in as necessary virtues in achieving the goals such a person is working hard to achieve (Fatubarin, 2019).

The establishment of new enterprises requires that some entrepreneurial activities should be carried out when economic opportunity or a business idea is created or identified. It also requires that one should evaluate opportunities in order to select the most promising one(s) for exploitation; consider all the resources needed, where and when to source for them and manage the resulting enterprise. This therefore indicates that to successfully exploit economic opportunities and establishing a new enterprise, an individual needs to carry out some activities. Explanations about small business establishment are carried out using one or a combination of three theoretical approaches: the nature of opportunities; the nature of entrepreneur; and the nature of the decision making context (Dionco-Adetayo, Atanda and Muhammed, 2012).

However, Contemporary studies now concentrate on the nature of the entrepreneur as an individual and this approach had generated a number of important and valuable issues, such as the effect of personality traits of entrepreneurs, socio-cultural, environmental and organisational factors on entrepreneurial success. Research focus on the entrepreneur, in recent times, is due to the fact that the entrepreneur is the principal agent that brings together other factors of production (i.e land, labour, information and capital) for productive purposes. Also, entrepreneur's activities bring about new enterprises that provide a very large proportion of innovative and valuable products and services that contribute to the way we work and live (Dionco-Adetayo, et al, 2012).

Many individuals in transitional economies may have the desire to pursue entrepreneurial ventures but are not doing so, because they are lacking in self-belief and perhaps in the desire to achieve results. Entrepreneurship is a key factor

for economic development. Public, private and non-governmental organizations are taking various measures to promote entrepreneurship in different countries. World class universities and colleges have implemented various postgraduate, undergraduate and diploma courses on small business management and entrepreneurship. In a developing country like Nigeria, the role of entrepreneurship is very important because of its role in the creation of self-employment opportunities and reduction in unemployment situations (Owoseni, 2012).

Paralleled with developing interest in entrepreneurship throughout the world, Nigeria also witnessed an increasing interest in entrepreneurship fields both among her academic scholars, and among government policy makers and business leaders. In course of time, some universities and vocational training institutes in Nigeria have incorporated entrepreneurship and small business management into their curriculum such as teaching photocopy and video production in educational technology so as to provide necessary exposure for students to entrepreneurial and industrial climate of the country. For decades, unemployment rate has been mounting. Recently, the global meltdown has also increased the unemployment level all over the world. This increased unemployment rate has created lots of problems both for the public and the government, like law-and-order situation, increased crimes and many social problems. One of the most effective alternatives suggested by the economists is self-employment (Fatubarin, 2019).

Self-employment or entrepreneurship has contributed immensely to the amount of output throughout the world and Nigeria is no exception. For developing economies, entrepreneurship works like an engine for economic growth, job creation and social adjustment. There have been consistent positive relationships between entrepreneurships intentions and personality traits.

Gartner (2012) says that the entrepreneurs are individuals with distinctive and specific personality traits. Personality traits have direct impact on many entrepreneurial activities including the intention to launch a new business, success in business, and enhance entrepreneurial set up. Realizing the importance of entrepreneurship for social and economic development of Nigeria, entrepreneurship is a topic requiring a lot of attention from academics and researchers. Entrepreneurship is the ability to create and build something from practically nothing. It is initiating, doing, achieving and building an enterprise or organization, rather than just watching, analysing or describing one. It is knack for sensing an opportunity where others see chaos, contradiction and confusion. It is the ability to build a "founding team" to complement your own skills and talents. It is willingness to take calculated risk, both personal and financial and then do everything possible to get the odds in your favour. An entrepreneur is one who created and grows a new enterprise and demonstrates characteristics of risk taking and innovation. Individuals who seek entrepreneurial careers are high in achievement motivation, take moderate risks, have more inclination and ability to innovate and have internal (rather than external) locus of control.

According to Olawoye (2008), small businesses contribute in no small way towards promoting industrial and economic development in any nation given the right environment. Their contributions have been well noticed over the years in the achievement of the following economic development objectives: employment generation; transformation of indigenous technology; utilization of local materials; increase of revenue for government; output expansion and production of intermediate goods.

Photocopy and Video Production Services

Production services mean motion picture and video processing, printing, editing, duplicating, animation, graphics, special effects, negative cutting, conversions to other formats or media, stock footage, sound mixing, re-recording sound sweetening, sound looping, sound effects, and automatic dialog replacement. Video production business means a person engaged in the production of motion pictures and videotapes for exhibition, sale, or for broadcast by a person other than the person producing the master copy of a video production. Video production business typically provides a variety of services, such as production services of motion picture or videography (Department of Revenue, 2022).

The Process of Photocopying

Popoola (2013) itemises the process of photocopying as follows:

i. copier's drum is given a positive change;

ii. the image from the original copy illuminates the charged drum and a latent image is formed;

iii. static electricity attracts toner to the drum surface and visible image is formed;

iv. toner on the drum is transferred to paper by positive charging;

v. after the image transfer is completed, the paper is separated from the drum surface;

vi. toner on the copy paper is firmly fixed when the paper runs between heat and pressure rollers;

vii. a cleaning blade wipes off excess toner;

viii. the drum is exposed by a neon lamp to erase the remaining static charge; and finally

ix. the paper comes out on the tray.

How to break into the Video Technology Field as a graduate

Build skills: It is essential to have a strong foundation in both the theoretical and practical aspect of video editing software, understand the basics of cinematography and get a grasp of post-production techniques, consider online tutorials or community college, courses to bolster your knowledge, practice shooting and editing your own video to apply what you have learned.

Gain Experience: Securing internships or entry-level positions is a crucial step towards entering the video technology industry. These opportunities provide you with real-world experience and a chance to see industry professionals in action. Aim to work on a variety of projects to broaden your skill set and understand different aspects of video production. Even volunteering for small projects or local organizations can be beneficial. Every bit of experience counts and helps build your resume, making you a more attractive candidate to potential employers.

Network Actively: Networking is key in the video technology sector. Start by connecting with alumni from your school who are working in the industry. Attend industry conferences, workshops, and seminars to meet professionals and learn about the latest trends and technologies. Join online forums and social media groups focused on video technology engaging with peers and experts can lead to valuable advice, mentorship opportunities and even job leads. Remember, the relationships you build now can open doors throughout your career.

Creativity, Innovation and Edutechpreneurship

Maa1uhali (2000) in Abiola and Ibitoye (2023) defined creativity as the ability to make or bring into being something, whether a new solution to a problem, a new method or device or a new artistic object form. Wyikoff (2000) in Abiola et al (2023) in his view sees creativity as "new and useful". It is the art of seeing things that everyone around us sees while making connections that no one else had made. Creativity could also be looked at, as moving from known to unknown, having the ability to generate new ideas by combining, changing or reapplying existing ideas. Some creative ideas are astonishing and brilliant, while others are first simple, good, of practical values that no one seems to have taught of yet. An entrepreneur or enterprise must recognise that modern business operates \n a world galloping with change which creates new problems that would mobilize the entrepreneur's resources so that the changes could make an impact.

Creativity is also known as the act of turning new and imaginative ideas into reality. The report of World Bank (2000) sees creativity as characterized by the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomena, and generate solutions. It is the process of bringing something new to being. It requires passion and commitment, bringing to our awareness what was previously hidden and pointing

to new life. Creativity involves two processes: thinking, then acting. For instance, a graduate of vocational and technical education with good ideas must also be able to be creative with the ideas must also be able to be creative with the ideas. So creating is the price of development, innovation pays the bills.

Druker (2007) in Abiola, et al (2023) argued that innovation is a tool of entrepreneurship. He added that both innovation and entrepreneurship demand creativity. Innovation refers to adding something new to an existing product or process. The keywords are "adding" and existing", the process or product has already been created from scratch and has worked reasonably well. When it is changed so that it works better or fulfils different needs, then innovation is carried out on what already exists. Innovation is the successful exploitation of new ideas all innovations begin with creative ideas.

Innovation is based on introducing change into a relatively stable system. The US Department of Labour (2002) described innovation as the implementation of a new or significantly improved product, service or process that creates value for business, government or society. It is concerned with the work required to make a creative idea viable. To be a youth, full of energy and potential is good, but empowering the youth for productive use of their natural strength and endowment is imperative for peace, employment generation and poverty reduction.

Educational Technology is an enlarged field of study that comprises two key words which are education and technology. Educational technology as a subject has its sole concern with the task of identifying the most suitable appropriate and developed technology (both hardware and software) for serving the educational needs and purposes of the students and the society at a particular time and place. As educational technology serves educational needs, it enhances the acquisition of skills, attitudes, values, culture, ideas, among others in students in turn affects the development of the society. Entrepreneurship on the other hand is the process of identifying, creating, and developing a new business venture with the aim of generating profit or value. It involves taking risks, innovating, and organizing resources to bring an idea to life. Essentially, it is about launching and running a business with the goal of making money while also potentially creating positive change. Photocopy and video production in educational technology are skills enhancing that if well mastered by the students stands to form a means of livelihood or makes one an entrepreneur in the workplace and even elsewhere.

Conclusion

Entrepreneurs are keen observers of the market, spotting unmet needs or gaps where they can offer a new product, service, or solution. Entrepreneurship often involves thinking outside the box and developing novel approaches to address problems or meet demands irrespective of the risk involved. Entrepreneurs need to gather the necessary resources, such as capital, personnel, and materials, to get their business off the ground. The ultimate goal of entrepreneurship is to create something of value, whether that is a product, a service, or a positive impact on society. Engaging in an entrepreneurial in a workplace is mainly to secure a key which is no other than profit making. Photocopy and video production, if embark on as business venture is capable sustaining lives and overcoming financial crises in an unstable economy with insatiable human needs.

Suggestions

For future development, this paper is making the following suggestions:

1. The curriculum planners should emphasise the need for continuous existence of entrepreneurship enhancing programmes in the curriculum at all levels of education because of its ability to create employment.

2. Government at all levels should accept and publish entrepreneurship as a hub of innovation that provides new product ventures, market, technology and quality of goods, as well as increase the standard of living of people.

3. The society and community should embrace the developmental impact of entrepreneurship as it assists the organisation towards a more stable and high quality of community life.

4. Individuals and families should tailor their mind towards entrepreneurship because it helps to improve the standard of living of a person by increasing the income.

5. The researchers should equally embrace entrepreneurial enterprise as it gives insights into making enquiries about new products which will promote research, general contribution, and development in the economy.

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ADOPTION OF DIGITAL TEACHING RESOURCES AMONG UNIVERSITY LECTURERS: A CBAM-BASED ANALYSIS OF STAGES OF CONCERN AND LEVELS OF USE

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Abstract

This study examined university lecturers' adoption of digital teaching resources using the Concerns-Based Adoption Model in selected universities in Ilorin, Nigeria. A correlational survey design was employed, and data were collected from 360 lecturers through a structured questionnaire measuring stages of concern and levels of use. Data were analyzed using descriptive statistics, Pearson correlation, and one-way ANOVA. The findings revealed that lecturers expressed higher concerns about the practical and collaborative aspects of adoption, while concerns about workload and changes in teaching roles were less prominent. Analysis of levels of use showed stronger engagement at the orientation, routine, and integration stages, with gradual progression toward adaptation and innovation, whereas outright non-use was minimal. A significant negative relationship was established between stages of concern and levels of use, suggesting that unresolved concerns limited adoption, while years of teaching experience did not significantly influence either variable. The study concluded that lecturers were increasingly ready to integrate digital teaching resources but required sustained institutional support and targeted professional development to advance toward higher levels of innovative practice.

Keywords: Digital teaching resources, CBAM, stages of concern, levels of use, lecturers, adoption, higher education

Introduction

The integration of technology into teaching and learning has led to a significant shift in higher education around the world. Digital teaching resources like e-learning platforms, learning management systems (LMS), simulations, open educational resources (OERs), and multimedia content have become indispensable tools for contemporary pedagogy in the twenty-first century. In addition to increasing knowledge accessibility, these resources open up possibilities for collaborative, flexible, and individualised learning settings that meet the needs of students who are digital natives (Bond et al., 2021; Hehir et al., 2021). This change was expedited by the COVID-19 pandemic, which forced universities all over the world to implement digital solutions at previously unheard-of levels, highlighting the enduring nature of technology-driven learning in higher education (OECD, 2021).

Like many developing nations, Nigeria has consciously worked to incorporate ICT (information and communication technology) into higher education. The Tertiary Education Trust Fund (TETFund) provides funding for digital resources, ICT infrastructure, and lecturer training, while the National Universities Commission (NUC) promotes the use of e-learning (Okoye & Obidike, 2021; TETFund, 2022). As part of national education strategies, the Federal Government also supports online learning and digital literacy at the policy level (Adedokun-Shittu & Ogunyinka, 2020). However, despite these efforts, insufficient infrastructure, erratic internet, a lack of technical support, and erratic power supplies continue to hinder the widespread adoption and efficient use of digital teaching resources (Oladipo & Adebayo, 2023). Additionally, lecturers' proficiency with technology varies; some are innovative in their pedagogical approaches, while others are limited to the most basic features (Umar & Hassan, 2021).

Since their attitudes, abilities, and willingness to try new things greatly influence whether technologies are used effectively or remain underutilised, lecturers are essential to the success of digital teaching resources in higher education (Chukwuemeka & Agboola, 2023). Adoption choices frequently depend on lecturers' opinions of the technology's usability, applicability, and educational value, even in cases where infrastructure is available (König et al., 2022). Therefore, adoption goes beyond access to include how instructors incorporate tools into their lessons; some resist because of workload or insufficient skills, while others try out strategies like flipped classrooms, gamification, and blended learning (Ojo & Adu, 2020). This range of behaviour, from apprehensive non-users to eager innovators, emphasises how more lecturers must be moved towards more in-depth and creative uses of digital resources if higher education is to undergo a sustainable digital transformation.

Lecturers are central to the success of digital teaching resources in higher education, as their attitudes, skills, and willingness to innovate largely determine whether technologies are meaningfully integrated or remain underused (Chukwuemeka & Agboola, 2023). Even when infrastructure is available, adoption decisions often hinge on lecturers' perceptions of ease of use, relevance, and pedagogical value (König et al., 2022). Adoption thus extends beyond access into how lecturers embed tools in practice, with some resisting due to workload or limited competence, while others experiment with approaches like flipped classrooms, gamification, and blended learning (Ojo & Adu, 2020). This spectrum of behaviour, from resistant non-users to enthusiastic innovators, underscores that sustainable digital transformation in higher education depends on shifting more lecturers toward deeper and more innovative uses of digital resources.

Adoption of digital resources in higher education is not a one-time occurrence but a continuous and evolving process. When new technologies are introduced, lecturers often experience initial concerns such as fear of change, lack of confidence, increased workload, and uncertainty about the value of the innovation (Alhassan & Adepoju, 2021). Studies highlight that adoption tends to progress through stages, beginning with awareness and moving through experimentation, adaptation, and eventual integration into teaching practice (Samuel & Adebayo, 2022). This process-based view of adoption underscores that success depends not only on the provision of infrastructure but also on strategies that build capacity and support lecturers at each stage of use.

Moreover, evidence shows that addressing lecturers' concerns plays a pivotal role in whether adoption is sustained. For instance, some lecturers initially adopt tools out of necessity, such as during the COVID-19 pandemic, but later discontinue usage due to unresolved challenges like technical difficulties or lack of institutional support (Bervell, Umar, & Arkorful, 2020). Others gradually evolve in their usage, moving from basic functionalities to more innovative applications once they gain confidence and see positive student outcomes (Owusu-Fordjour & Essel, 2023). This suggests that effective adoption strategies should not only emphasize access to technology but also foster an enabling environment where lecturers' evolving needs and concerns are actively addressed.

The Concerns-Based Adoption Model (CBAM) has emerged as one of the most widely recognized frameworks for examining the complexities of technology adoption in educational contexts. Unlike models that treat adoption as a simple binary (use or non-use), CBAM emphasizes the dynamic nature of change, recognizing that individuals experience both psychological and behavioural shifts as they engage with innovations. The model identifies two primary dimensions: Stages of Concern (SoC), which track educators' feelings, worries, and reflections from initial awareness to possible refocusing of the innovation, and Levels of Use (LoU), which describe the behavioural patterns of adoption ranging from complete non-use to renewal and creative reinvention (Hall & Hord, 2020; Shrestha & Dissanayake, 2021). These dimensions offer a comprehensive way to capture both the mindset and practice of lecturers as they navigate the adoption of digital teaching resources.

CBAM's strength lies in its ability to bridge the gap between individual concerns and observable practices, making it particularly suitable for higher education studies. Recent research highlights that adoption challenges often stem from not only inadequate infrastructure but also from lecturers' varying stages of readiness and patterns of engagement (Van der Merwe & Kotzé, 2022; Adewumi & Owolabi, 2023). By using CBAM, this study can reveal whether university lecturers in Nigeria are still grappling with concerns about workload and competence, or whether they have progressed to innovative uses of digital tools in pedagogy. Thus, the framework provides a nuanced lens to assess adoption as both a psychological journey and a behavioural trajectory, offering insights critical for policy, professional development, and sustainable ICT integration.

Research on ICT integration in Nigerian higher education has grown, but most studies emphasize digital competence, infrastructure, or general challenges without using systematic frameworks to explain adoption (Afolayan & Yusuf, 2021; Olanrewaju & Joshua, 2023). Few have applied the Concerns-Based Adoption Model (CBAM) to link lecturers' concerns with their actual use of digital tools, leaving gaps in understanding how perceptions shape practice. Ilorin, home to universities such as the University of Ilorin, Kwara State University, and Al-Hikmah University, provides a useful setting, as significant ICT investments coexist with uneven adoption ranging from innovation to reluctance. Applying CBAM offers insights to guide professional development and institutional strategies while contributing to Sustainable Development Goal 4 on quality education (UNESCO, 2022).

Statement of the Problem

The global shift to technology-enhanced learning has made digital teaching resources essential for modern pedagogy, yet adoption in higher education remains uneven due to workload, competence, and confidence challenges (Shrestha & Dissanayake, 2021; Van der Merwe & Kotzé, 2022). In Nigeria, despite major investments by the National Universities Commission (NUC) and TETFund, lecturers' use remains inconsistent, some integrate tools innovatively while others show reluctance or minimal use (Adewumi & Owolabi, 2023). Adoption is thus shaped less by access than by lecturers' concerns, attitudes, and practices. However, most Nigerian studies focus on infrastructure and competence, with few applying frameworks like the Concerns-Based Adoption Model (CBAM), which links psychological concerns to behavioral use (Afolayan & Yusuf, 2021; Olanrewaju & Joshua, 2023). Consequently, little is known about how lecturers' perceptions translate into practice, especially in Ilorin universities where ICT investments coexist with uneven adoption. Without such evidence, professional development risks being generic and poorly aligned with lecturers' real needs, underscoring the relevance of this study.

Objectives of the study

The following are the specific objectives of this study:

1. determine the stages of concern of university lecturers regarding the adoption of digital teaching resources.
2. ascertain the levels of use of digital teaching resources among university lecturers.
3. examine the relationship between lecturers' stages of concern and their levels of use of digital teaching resources; and
4. determine the influence of lecturers' years of teaching experience on the stages of concern in adopting digital teaching resources.
5. determine the influence of lecturers' years of teaching experiences on the levels of use of digital teaching resources.

Research Questions

1. What are the stages of concern of university lecturers in adopting digital teaching resources?

2. What are the levels of use of digital teaching resources among university lecturers?

Research Hypothesis

H_{01}: There is no significant relationship between university lecturers' stages of concern and their levels of use of digital teaching resources.

H_{02}: There is no significant influence of lecturers' years of teaching experience on their stages of concern in adopting digital teaching resources.

H_{03}: There is no significant influence of lecturers' years of teaching experience on their levels of use of digital teaching resources.

Methodology

The study employed a correlational survey design to examine the relationship between stages of concern and levels of use in the adoption of digital teaching resources among university lecturers in Ilorin Metropolis, Kwara State. The population comprised lecturers from two universities (a public and a private university), from which a stratified random sample of 360 was drawn using proportionate allocation. Data were collected with the Lecturers' Adoption of Digital Teaching Resources Questionnaire (LADTRQ), adapted from the Concerns-Based Adoption Model (CBAM). The instrument comprised three sections: Section A (demographics), Section B (10 items from the Stages of Concern Questionnaire), and Section C (10 items from the Levels of Use framework), rated on a 4-point Likert scale from Strongly Disagree (1) to Strongly Agree (4). Face and content validity were confirmed by three experts in Educational Technology and Measurement and Evaluation. A pilot test with 30 lecturers outside the sample produced Cronbach's alpha values of 0.876 (SoC) and 0.842 (LoU), confirming reliability. Data collection, conducted over four weeks via physical and electronic administration, was analyzed using descriptive statistics (mean and standard deviation) for research questions, and Pearson Product Moment Correlation (PPMC) and ANOVA to test hypotheses at the 0.05 significance level.

Results

Analysis of Research Questions

Research Question 1: What are the stages of concern of university lecturers in adopting digital teaching resources?

Table 1

Lecturers' Stages of Concern (SoC) on Adopting Digital Teaching Resources

Item	SA	A	D	SD	Mean	Std. D
I am concerned about how digital teaching resources will affect my existing teaching routine.	156	120	41	43	3.08	1.01
I feel I need more information on the types and purposes of available digital teaching resources.	139	100	55	66	2.86	1.12
I worry that using digital resources will increase my workload.	45	131	127	57	2.42	.90
I am primarily interested in whether digital resources will improve my students' learning outcomes.	166	104	43	47	3.08	1.04
I am curious about how other lecturers use digital teaching resources in their courses.	53	116	122	69	2.42	.96
I often think about new or better ways to use digital resources to improve my teaching.	119	125	54	62	2.84	1.07
I am confident I know enough about digital teaching tools to begin using them in my classes.	134	113	47	66	2.88	1.10
I am mainly concerned with the logistics of using digital tools (time, scheduling, management).	147	121	47	45	3.03	1.02
I believe collaborating with colleagues would improve how I use digital teaching resources.	157	124	43	36	3.12	.97
I frequently reflect on how using digital resources changes my role as a lecturer	42	112	136	70	2.35	.92

Key; *SD* = Strongly Disagree, **D** = Disagree, **A** = Agree, **SA** = Strongly Agree
Decision Value: = 2.50

The analysis of lecturers' stages of concern in adopting digital teaching resources in Table 1 shows that the majority of respondents expressed relatively high concern across most stages, with mean values above the decision benchmark of 2.50. The highest concerns were in collaboration (M = 3.12), consequence in terms of student learning outcomes (M = 3.08), and personal impact on teaching routines (M = 3.08). Informational (M = 2.86), management (M = 3.03), refocusing (M = 2.84), and confidence to begin usage (M = 2.88) were also above the criterion, indicating substantial concern and readiness. However, concerns about workload (M = 2.42), curiosity about colleagues' practices (M = 2.42), and reflection on changes in their teaching role (M = 2.35) fell below the decision value, suggesting that these issues are of relatively low importance to lecturers. Overall, the results imply that lecturers are more concerned with the practical and collaborative aspects of adopting digital teaching resources than with workload or role-change implications.

Research Question 2: What are the levels of use of digital teaching resources among university lecturers?
Table 2
Lecturers' Levels of Use (LoU) of Digital Teaching Resources

Item	SA	A	D	SD	Mean	Std. D
I do not currently use digital teaching resources in my courses.	48	118	128	66	2.41	.93
I seek out basic orientation information (how-to guides, short tutorials) before trying a digital tool.	220	94	46	0	3.48	.71
I deliberately plan lessons that incorporate digital resources with clear instructional goals.	140	102	67	51	2.92	1.07
When I first use a new digital tool, I tend to follow step-by-step procedures rather than adapt it creatively.	175	124	24	37	3.21	.96
I use certain digital tools regularly in my courses and they have become part of my routine.	202	99	59	0	3.39	.75
I modify and adapt digital resources to better fit my students' needs.	157	91	67	45	3.00	1.06
I integrate multiple digital resources and design activities that rely on them for student learning.	179	98	83	0	3.27	.81
I often evaluate and improve my use of digital tools based on student outcomes and feedback.	162	89	65	44	3.03	1.06
I sometimes invent new ways of using digital resources that go beyond their intended purpose.	167	105	40	48	3.09	1.05
If equipment or access is unavailable, I can still achieve my lesson objectives without digital resources.	175	118	67	0	3.30	.76

Key; *SD* = Strongly Disagree, **D** = Disagree, **A** = Agree, **SA** = Strongly Agree
Decision Value: = 2.50

The analysis of lecturers' Levels of Use (LoU) of digital teaching resources in Table 2 indicates that most categories recorded mean scores above the 2.50 benchmark, reflecting active utilization. Orientation (M = 3.48), routine use (M = 3.39), integration (M = 3.27), and mechanical use (M = 3.21) emerged highest, suggesting that lecturers often seek guidance before adopting tools, have embedded some digital resources into their teaching routines, and combine them to enhance learning. Innovation (M = 3.09), evaluation/refinement (M = 3.03), adaptation (M = 3.00), and preparation (M = 2.92) also surpassed the cut-off, showing that lecturers engage in planning, modification, and occasional creation of new applications. Only non-use (M = 2.41) fell below the benchmark, confirming that outright rejection of digital tools is rare. Interestingly, the ability to meet lesson objectives without technology (M = 3.30) suggests flexibility in teaching approaches. Overall, the results indicate that lecturers operate across multiple LoU stages, with stronger engagement in orientation, routine, and integration, while also demonstrating gradual movement toward adaptation and innovation.

Hypotheses Testing

Hypothesis One: There is no significant relationship between university lecturers' stages of concern and their levels of use of digital teaching resources.

Table 3:

Summary of Pearson Product Moment Correlation Showing Relationship between Lecturers' stages of concern and their levels of use of digital teaching resources

Variable	Mean	Std. D	N	R	Sig(p)	Remark
Stages of Concern	28.11	3.03	360	-.351	.004	Significant
Level of Use	31.10	3.11				

Table 3 presents the Pearson Product Moment Correlation analysis examining the relationship between lecturers' information literacy skills and their intention to adopt AI tools for research output. The results indicate a negative and significant correlation between the two variables ($r = -0.513$, $p = 0.001$). Hence, hypothesis 1 is rejected.

Ho2: There is no significant influence of lecturers' years of teaching experience on their stages of concern in adopting digital teaching resources.

Table 4:

Summary of One-Way ANOVA Showing Differences in Lecturers' Stages of Concern Across Years of Teaching Experience in Adopting Digital Teaching Resources

ANALYSIS OF VARIANCE

Model	Sum of Squares	df	Mean Square	F	Sig.	Remark
Between Groups	42.727	4	10.682	1.165	.326	Not Significant
Within Groups	3253.603	355	9.165			
Total	**3296.331**	**359**				

A one-way ANOVA was conducted to determine whether lecturers' stages of concern differed significantly across years of teaching experience in adopting digital teaching resources. The result indicated no significant difference among the groups, $F(4, 355) = 1.17$, $p = .326$. This suggests that lecturers' years of teaching experience did not significantly influence their stages of concern in adopting digital teaching resources. Therefore, the null hypothesis was not rejected.

Ho3: There is no significant influence of lecturers' years of teaching experience on their levels of use of digital teaching resources.

Table 5:

Summary of One-Way ANOVA Showing Differences in Lecturers' Levels of Use of Digital Teaching Resources Across Years of Teaching Experience

ANALYSIS OF VARIANCE

Model	Sum of Squares	df	Mean Square	F	Sig.	Remark
Between Groups	36.612	4	9.153	.947	.437	Not Significant

Within Groups	3430.586	355	9.664
Total	**3467.197**	**359**	

A one-way ANOVA was conducted to determine whether lecturers' levels of use of digital teaching resources differed significantly across years of teaching experience. The result revealed no significant difference among the groups, $F(4, 355) = 0.95$, $p = .437$. This implies that lecturers' years of teaching experience did not significantly influence their levels of use of digital teaching resources. Therefore, the null hypothesis was not rejected.

Discussion of Findings

Lecturers in this study emphasized practical, hands-on, and collaborative aspects of adopting digital teaching resources over workload or role-change concerns. This aligns with the CBAM view that teachers' early concerns focus on information and management needs to support classroom practice (Hall & Hord, 2015). Studies confirm that practice-oriented professional development and professional learning communities (PLCs) enhance integration by offering concrete strategies and peer support, which reflect the priorities highlighted here (Liu et al., 2024). Similarly, Uzorka et al. (2023) found that situated, hands-on training reduces workload anxieties, while evidence from emergency transitions shows workload becomes a concern when institutional supports are weak.

Findings also revealed that most lecturers operate across multiple CBAM levels, with stronger engagement in orientation, routine, and integration, and gradual movement toward adaptation and innovation. This pattern is typical when innovations are actively diffusing, with many settling into routine use while a smaller group pursue reinvention (Hall & Hord, 2015). Comparable studies report the same distribution in higher education technology adoption (Olson et al., 2020), and recent evidence shows PLCs help lecturers advance from training into sustained integration (Liu et al., 2024). Encouragingly, the presence of lecturers at adaptation and innovation stages mirrors findings that motivated or well-supported faculty often emerge as early innovators and champions of change (Uzorka et al., 2023).

The significant negative correlation between lecturers' stages of concern and their levels of use of digital teaching resources indicates that higher concerns are associated with lower adoption. This finding aligns with evidence from a Nigerian study that applied CBAM to assess teachers' concerns about ICT integration, showing that many teachers expressed intense concerns at early stages, which translated into inconsistent or minimal use of digital tools (Dele-Ajayi et al., 2021). Similarly, research on ICT usage among lecturers at the University of Uyo revealed that external barriers such as inadequate infrastructure and insufficient training heightened concerns and reduced regular use of digital resources (Nwonye et al., 2025).

The finding that years of teaching experience did not significantly predict either stages of concern or levels of use supports evidence that demographic factors such as age or tenure are weak determinants of technology adoption once more proximal variables, such as access to professional development (PD), self-efficacy, and institutional support, are considered (García-Martín et al., 2023; McGehee, 2024). While earlier studies suggested younger or less-tenured staff may experiment more, these differences often disappear when opportunities for quality PD and exposure are comparable. Recent work further shows that actual use is driven more by perceived usefulness, confidence, and facilitating conditions than by years of service (Uzorka et al., 2023).

Conclusion

This study explored the adoption of digital teaching resources among university lecturers through the CBAM framework. Results showed that lecturers prioritized practical and collaborative aspects of adoption over workload or role-change concerns, reflecting their preference for tools that enhance efficiency, engagement, and peer support. They were distributed across several CBAM levels, with strong presence in orientation, routine, and integration, and gradual progression toward adaptation and innovation. A significant relationship emerged between stages of concern and levels of use, confirming the interdependence of perception and practice. Teaching experience, however, did not significantly influence either concerns or levels of use, suggesting that contextual and institutional supports are more critical drivers. Overall, the findings underscore lecturers' readiness for digital integration and the need for sustained institutional support to foster innovation.

Recommendations

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

1. Universities should provide professional development programs that build both technical skills and pedagogical strategies for effective use of digital teaching resources.
2. Institutions should ensure adequate support structures such as reliable internet access, updated digital tools, and instructional design assistance to reduce barriers to adoption.
3. Universities should promote peer mentorship and communities of practice where early adopters guide colleagues through different stages of adoption.
4. Management should regularly monitor lecturers' concerns and levels of use in order to provide timely and responsive interventions.

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